COORDINATED HIGHWAYS ACTION RESPONSE TEAM
STATE HIGHWAY ADMINISTRATION

CHART Business Area Architecture Revision 9

Contract SHA-06-CHART
Document # WO1-BA-001R9

August 31, 2011
By
CSC

Document Change Control

Date	Summary of Changes	Pages Affected	Document Revision Number
01/25/08	BAA update for CHART Release 3 Build 1	Cover, 1, 45, 145, A-2-4	R1
10/08/08	BAA update for CHART R3B2	Cover,1, 3, 40, 47, 48, 49, 61, 64, 89, 119, 146, Appendix A	R2
12/11/09	BAA update for CHART R3B3	Cover, 1, Section 10.1.6, Fig 10.2-1 Appendix A	R3
4/28/10	BAA update for CHART R4	Cover,145,Fig 10.2-1 Appendix A	R4
9/21/10	BAA update for CHART R5	Cover,145,Fig 10.2-1 Appendix A	R5
01/03/11	BAA update for CHART R6	Cover,145,Fig 10.2-1 Appendix A	R6
07/07/11	BAA update for CHART R7	Cover,145,Fig 10.2-1 Appendix A	R7
07/07/11	BAA update for CHART R8	Cover,145,Fig 10.2-1 Appendix A	R8
08/31/11	BAA update for CHART R9	Cover,145,Fig 10.2-1 Appendix A	R9

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1 Executive Summary

The current CHART System is the culmination of work spanning across multiple contracts and vendors using a Business Area Architecture (BAA) developed in 2000 and this BAA developed in early 2007. Revision 9 of this document is an update to reflect the work completed in Release 9 of CHART.

A BAA document describes:

- A developed, aligned, and communicated **business vision**
- Designed **business processes** including relationship to **organizations**, **technology**, and facilities
- Defined, distributed, and integrated **applications** and **data** entities across platforms and **locations**
- A developed **architecture** at the conceptual level for technical infrastructure
- Defined, interrelated, and scheduled **releases** within the business change program

The scope and operational priorities of the CHART System have shifted since the publication of the original BAA document. The following imperatives drive the need to update the BAA:

- New technology and innovative solutions
- New standards to facilitate interoperability between intelligent transportation systems (ITS) component devices and software.
- post-9/11 and post-Katrina security and emergency preparedness issues (e.g., DHS)
- Increased imperative for improved coordination and integration between Maryland, its neighbors, and the federal government

In addition to the BAA being out-dated, the evolution of CHART over the past 10+ years (as supported by multiple vendors, multiple contracts, and emerging priorities) has resulted in requirements that are scattered in multiple documents and requirements management systems.

In order to ensure that the foundation for the future development of CHART is solid, the BAA and the requirements that came from it need to be refreshed. This document reflects the efforts of a cross-functional CHART business team to accomplish this. The key recommendations for success that were identified by BAA participants included:

- Connection to SHA Signal System – a communications infrastructure needs to be designed, funded and implemented.
- Detection – Many of CHART's requirements defined in this document can only be partially reached unless a detection infrastructure (leased or built) can be implemented.
- Communications – Integration with 911 Centers and support of RITIS. CHART should help guide RITIS into a 24/7 fully supported program.

These three key items, that are each projects unto themselves, will be the key areas that can take CHART to the next level of Traffic Management for the State of Maryland.

This document includes an Introduction and overview (Sections 2 and 3, respectively), and detailed sections of all key business areas (Process, Organization, Location, Data, Application, and Technology; Sections 4 through 9, respectively). Each of these detailed sections begins with the vision, principles, constraints, and assumptions that guided the analysis of each area; and ends with recommendations for improvement in that area. Section 10 describes the Release Strategy for implementing the improvement recommendations across all the business areas. It provides a System Release Plan (for the Process, Data, Application, and Technology areas) and an Organization Recommendations Plan (for the Organization and Location areas) that provides suggested implementation timeframes. Appendices provide information that supplements the major sections.

2 Introduction

This introduction includes:

- CHART program background
- BAA project background
- BAA approach and methodology

2.1 CHART Program – Background

CHART (Coordinated Highways Action Response Team) is a joint effort of the Maryland Department of Transportation and the Maryland State Police, in cooperation with other federal, state and local agencies. CHART's mission is to improve "real-time" operations of Maryland's highway system through teamwork and technology. The CHART program relies on communication, coordination, and cooperation among agencies and disciplines, both within Maryland and with neighboring states, to foster the teamwork necessary to achieve its goal. This is consistent with Maryland's State Highway Administration's overall mission, which is to provide Maryland with an effective and efficient highway system.

The CHART program is Maryland's entry into the ITS (Intelligent Transportation System) arena, and started in the mid-1980s as the "Reach the Beach" initiative, focused on improving travel to and from Maryland's eastern shore. It has become so successful that it is now a multi-jurisdictional and multi-disciplinary program, and its activities have extended not just to the busy Baltimore-Washington-Annapolis-Frederick corridors, but into a statewide program. The program is directed by the CHART Board, consisting of senior technical and operational personnel from SHA, Maryland Transportation Authority (MdTA), Maryland State Police (MSP), Federal Highway Administration, the University of Maryland Center for Advanced Transportation Technology (UMd CATT Lab), and various local governments. The board is chaired by the Chief Engineer of the SHA. This comprehensive, advanced traffic management system is enhanced by a state-of-the-art command and control center called the Statewide Operations Center (SOC). The SOC is the "hub" of the CHART system, functioning 24 hours a day, 7 days a week, with satellite Traffic Operations Centers (TOCs) spread across the state to handle peak-period traffic.

2.2 Business Area Architecture (BAA) Project - Background

The current CHART System is the culmination of work spanning across multiple contracts and vendors using a Business Area Architecture (BAA) developed in 2000. A BAA is document that describes:

- A developed, aligned, and communicated **business vision**
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2.3 Business Area Architecture Updated - Approach and Methodology

The purpose of this task is to update the BAA. The approach for this is illustrated in Figure 2.3-1, summarized in the paragraph below, and detailed in the subsections that follow.

As the figure suggests, the first step is to analyze the “as-is” situation by reviewing current CHART documentation, and to validate that analysis at a BAA kickoff and scope verification workshop. This is followed by a vision workshop and a series of “to-be” workshops to detail that vision. After the “to-be” high-level requirements are determined, a gap analysis is done to compare the existing “as-is” requirements to the new “to-be” requirements.

Based on the final list of new baselined requirements, a release strategy and plan is developed to guide the next phases of the CHART evolution. This strategy and plan will include not only the requirements for the application and data changes, but also the requirements for associated policy, process, and procedure changes; technology implementation; and organizational changes and training.

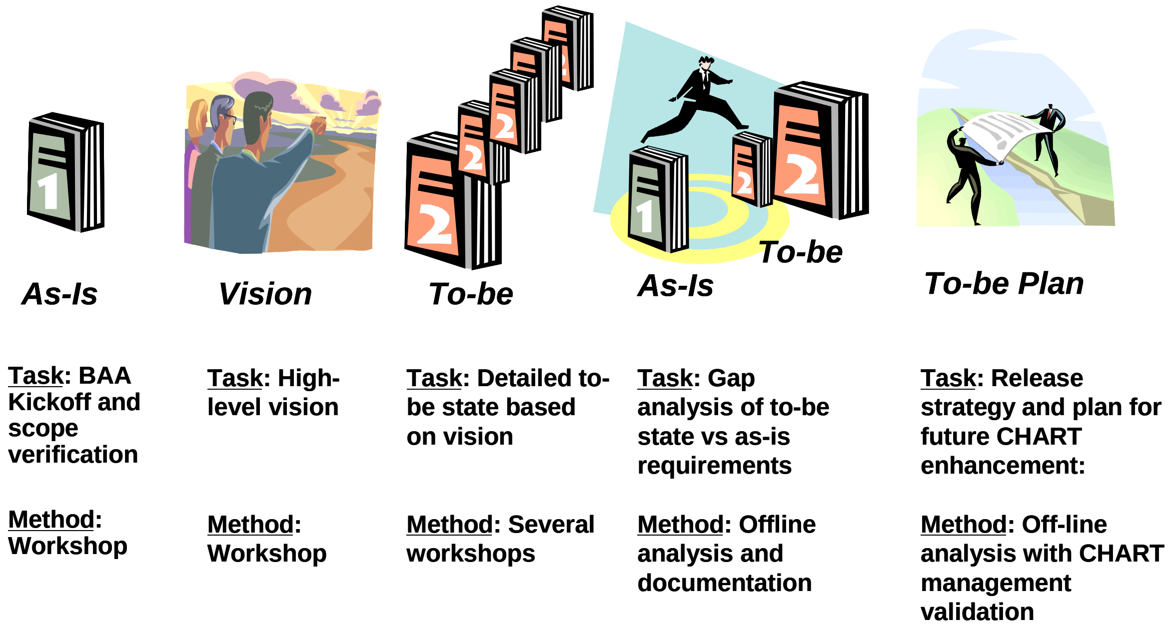


Figure 2.3-1 - BAA Update Approach

2.3.1 As-Is Analysis and Scope Verification; To-Be Vision

In preparing for the BAA kickoff and scope verification update, the project team reviewed numerous documents including, but not limited to:

- Prior BAA (including interview with CHART management to assess what parts were most useful)
- CHART Functional Vision document in January 2001,
- CHART Business Plan, completed in 2003, which included an unconstrained vision for CHART (wish list).
- System-level and software requirements for CHART and related systems (CHART II, Mapping, Video, EORS, etc.)
- CHART user documentation and system documentation

A workshop was conducted with key CHART stakeholders to validate the as-is analysis, the scope and purpose of the BAA update initiative, and the goals for CHART in terms of both pictures and words that describe the case for action and vision of the future state.

2.3.2 To-Be Details

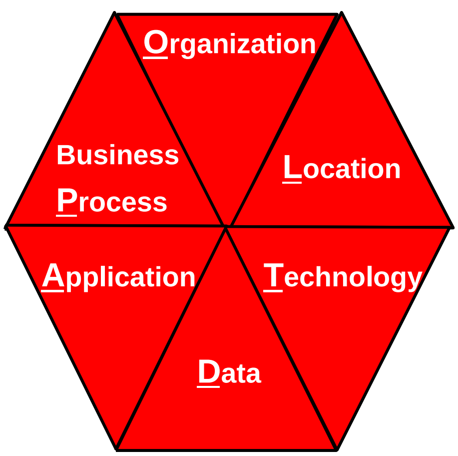
Following the initial “as-is” and vision workshops, a series of workshops was conducted to fully define the high-level requirements for the future CHART. The guiding principles and methods for guiding this activity include:

- Carefully planned, facilitated discussions that produce decisions that about new direction in processes, technology, requirements.
- Workshop format that produces highest quality results in least amount of time with shared input and buy-in.
- Off-line preparation (e.g., facilitator research, participant read-aheads) that optimizes workshop time.
- Cross-functional, dedicated resources that increases horse-power.

With respect to the last item in the list above, representatives from the following groups were invited to attend the workshops:

- SHA management
- CHART and MdTA operations leads
- SHA Project Managers and Task Leaders
- Partners from University of Maryland
- CHART users
- Representatives from groups that want to contribute to or receive data from SHA CHART's near future Center-to-Center capability (e.g., CAPWin)
- Outside subject matter experts (SMEs) from Team CSC

The topics for these workshops were based on CSC's holistic approach to business area architectures which is to address all areas of a business situation - -the ***p***rocesses, ***o***rganization, ***l***ocation, data, ***a***pplication, and ***t***echnology – or POLDAT, for short. Each of these areas is shown in the figure below and briefly described in the paragraph the follows. The figure suggests that all areas are integrally related – like pieces of a pie -- and affect one another.



- **Business Process.** Focuses on what the customer does, how activities are carried out and in what sequence, what rules are followed, and type of results obtained.
- **Organization.** Focuses on people and organizations involved in the change; their culture, capabilities, roles, team structures, and organizational units.
- **Location.** Focuses on where business is conducted; e.g., physical facilities such as a branch office or data center, customer and vendor sites.

Figure 2.3.2-1 CSC's Holistic Approach for BAA

- **Data.** Focuses on content, structure, relationships, and business rules for data used by business processes, applications, and organization.

- **Application.** Focuses on capabilities, structure, and user interface of software applications and application components used to support the change.
- **Technology.** Focuses on hardware, system software, and communications infrastructure used to enable and support solutions and services.

In addition to the POLDAT-based workshop topics, special topics were also addressed in the workshops to cover related information in a more focused way (e.g., Federal and State ITS standards, external system interfaces). The full list of workshop topics is listed below. Note that they are listed in a topically related way and not necessarily in the order in which they occurred.

- Kickoff; Case for Action and Vision
- Process - Traffic Monitoring
- Process - Incident Management
- Process - Traffic Management
- Process - Traveler Information and Performance Management
- Process - Administer System and Devices
- Organization
- Location
- Data
- Application
- Technology
- Federal/State ITS Standards
- External Traffic Management Interfaces
- Emergency Preparedness and Homeland Security

2.3.3 Gap Analysis

While the new requirements were being identified in the workshops, the existing requirements were collated, cataloged, and grouped to logically consolidate them. Once all the new high-level requirements are identified for the areas listed above, a gap analysis is done to compare the new requirements to the consolidated existing requirements. The purpose of the gap analysis is to determine:

- What's been done
- What still needs to be done
- What no longer needs to be done
- What needs to be done that hadn't been identified before

2.3.4 Release Strategy and Plan

The release strategy and release plan presented here describes an approach to systems development that builds and deploys the CHART system in a series of releases and builds. As opposed to the "big-bang" approach, the multiple release strategy is done to divide the system into manageable sized pieces that:

- Provide enhanced functionality for CHART in a sequence consistent with operational needs.
- Lessen the impact on the operations personnel regarding training on the enhanced functionality.
- Provide reasonably sized sets of code for development, testing, and documentation.
- Allow for iterative process and system improvements over successive releases.

This release strategy and plan includes more than just the application- and data-related requirements. It includes all of the suggestions for process, technology, organizational, and location changes as well. It is important that all of these areas be considered together since there are often dependencies. Example: There's no point in developing a user interface to control a new device type until it the device type has an operational requirement.

To guide the decision process for determining the releases, the first step is to classify the requirements by their relative business value and their relative ease/difficulty of implementation. Note: This is not an exact science. "Business value" may mean business value for customers, stakeholders, users, etc. "Ease" may mean technically easy, politically easy, fiscally easy, etc. The CHART Management Team and the CSC Project Team collaborated to assess each requirement and plot it on a chart similar to that shown in the figure below.

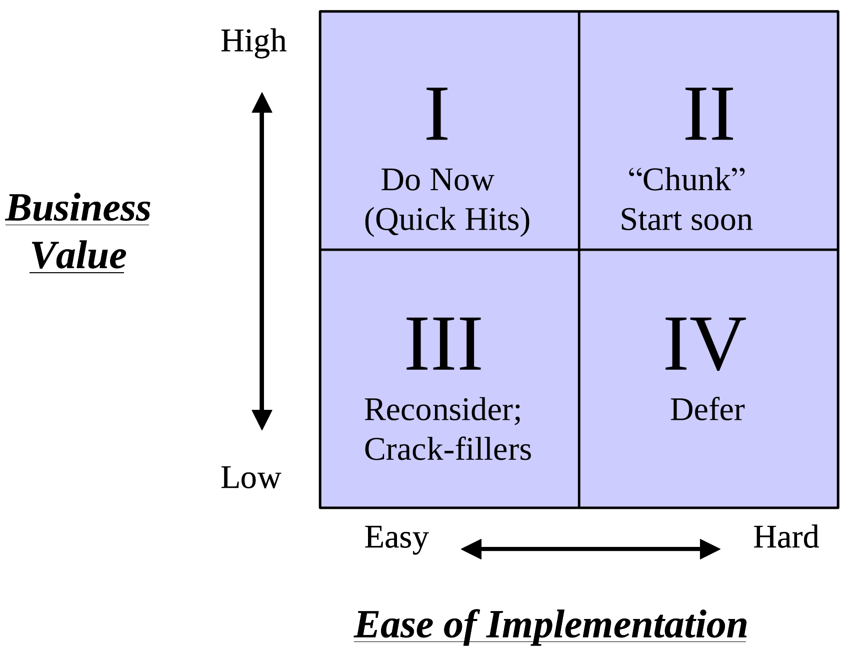


Figure 2.3.4-1 – Value-Ease Matrix for Developing Release Strategy

Once each requirement is plotted, the planning step allocates each requirement to a release based on a combination of factors:

- Position on the value-ease matrix
- Blend of requirements from different points on the matrix
- Interdependence of requirements
- The volume of work represented by each requirement.

The release planning activity follows the general guidelines below:

- The first [post-BAA] release (CHART Release R3B1) includes many of the items from quadrant I (top left; to deliver as much business value as soon as possible), some from quadrant II (top right; to get started on the more difficult but very important requirements), only as many from quadrant III (bottom left) that must be done to satisfy a specific business urgency, none from quadrant IV (bottom right).
- The second release/build includes any remaining (or new emerging) items from quadrant I, more from quadrant II (to continue to progress on the more difficult but very important requirements), only as many from quadrant III that must be done to satisfy a specific business urgency, none from quadrant IV.
- The third and subsequent releases and builds are similar to the second release except that they will have fewer quadrant I requirements (since they will mostly have been completed), more of the quadrant III requirements, and some requirements from quadrant IV may need to be done.

Both the plotting of the requirements on the Value-Ease matrix that defines the release strategy, and the resulting release plans are validated with CHART management to ensure that the releases fully meet the priorities of the mission goals of CHART. The Release Strategy and Plan is described in Section 10.

3 Overview of CHART Direction

This section includes an overview of:

- CHART's mission and goals
- CHART's Case for Action
- CHART's Vision
- High-level CHART business processes

3.1 Mission and Goals

The mission and goals are what drive operations and decision-making in an organization. CHART's mission statement is:

> *To improve mobility and safety for the users of Maryland's highways through the application of ITS technology and interagency teamwork.*

CHART's **goal is to ensure mobility and safety for the users of Maryland's Roadway network through the application of management and operations and interagency teamwork.** The specific objectives and the measurement of the success of meeting that objective are outlined below.

- **OBJECTIVE: ROADWAY MONITORING**
  Increase availability of key incident data in the Baltimore/Washington Metropolitan Area.
  Measurement: Percent increase of captured incident data

- **OBJECTIVE: INCIDENT MANAGEMENT**
  Provide effective incident management that reduces non-recurring delay (in vehicle hours) to achieve related cost savings for the traveling public, including commercial traffic.
  Measurement: Delay by vehicle hours / cost savings during non-recurring congestion

- **OBJECTIVE: TRAFFIC MANAGEMENT**
  Provide effective traffic management that reduces recurring delay (in vehicle hours) to achieve related cost savings for the traveling public, including commercial traffic.
  Measurement: Delay by vehicle hours / cost savings during recurring congestion

- **OBJECTIVE: TRAVELER INFORMATION**

Achieve greater positive customer feedback regarding traveler information.
Measurement: Feedback from website / media coordination meetings / postcards

- **OBJECTIVE: EMERGENCY OPERATIONS**
  Complete specified number of programmed Emergency Operations related enhancements, developments, and plans.
  Measurement: Percent of completed initiatives

- **OBJECTIVE: EMPLOYEE SATISFACTION**
  Increase employee satisfaction based on positive feedback on employee surveys.
  Measurement: Percentage of overall employee satisfaction

- **OBJECTIVE: BUSINESS PROCESSES**
  Establish documented procedures to improve CHART's internal controls for procurement, inventory, and asset management.
  Measurement: Creation of documented procedures for procurement, inventory, and asset management

The specific strategies for meeting these goals are outlined in the Business Plan for the Office of CHART and ITS Development FY 2004-2007.

3.2 Case for Action

The primary business issues that inhibit CHART from reaching all of its goals and fulfilling its mission are documented in a Case for Action. The purpose of a case for action is to provide a clear and succinct summary of the issues to justify the reason why change is required. Some of the key elements of CHART's current case for action are illustrated in the picture below.

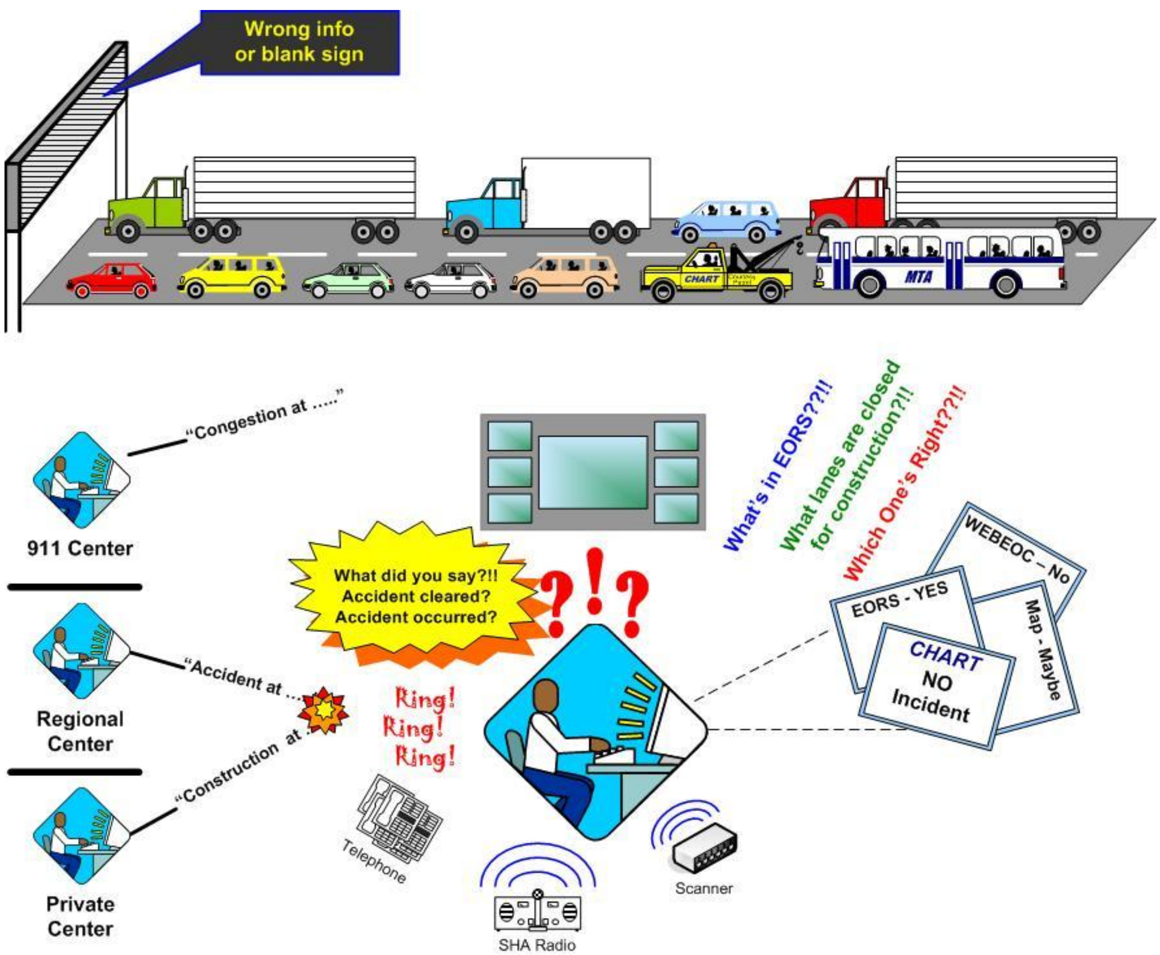


Figure 3.2-1 - Case for Action Graphic

As the picture depicts in the center, currently CHART operators are multi-tasking data entry clerks that have too many non-automated inputs such as phones, scanners, faxes, and camera views. They also have too many automated systems that are not integrated (e.g., CHART, EORS, WebEOC) that can have incomplete or conflicting information. There is also a lot of data from other entities such as 911 centers, regional centers, and private organizations, but this data is not consolidated, is often conflicting and does not go into CHART. As a result of the lack of integrated systems and data, little or sometimes incorrect information is provided to the traveling public, as is shown in the area at the top of the diagram (there is heavy traffic on one road but the DMS message has wrong information or is blank.

While the graphic above symbolically represents some of the key issues that inhibit CHART from reaching all of its goals and fulfilling its mission, the specific issues are more fully described in the table below. These statements were derived from workshops with CHART Users, Management, and Partners.

Figure 3.2.2 - Case for Action Statements

Case for Action Statement	Supporting Statements
Too many systems; not enough integration.	Inaccurate or inconsistent data prevents us from getting timely, accurate information to the traveling public and incident responders. Weak integration with external systems (e.g., such as Web EOC and third party systems) and some of our own separate systems (e.g., EORS) means: • We don't have the whole picture. • We have to reenter data in multiple systems vs. having the systems talk to each other. • We have conflicting data (e.g., notifications) and don't know what to believe. • Our sign messages are sometimes inaccurate or inconsistent. • The traveling public has no efficient way of knowing what's go on the highways. • We cannot act proactively (e.g., the CHART scheduler) to provide good, automated support to the CHART operators. Lack of standards for inter- and intra-agency processes and communication make it difficult to coordinate appropriate and timely response to incidents and get good information. Low equipment reliability and resource-constrained maintenance reduces the integrity and completeness of the data we do receive. Example: If we have no camera information or drivers in the area of an incident, we are not able to capture and relay accurate information or even respond.
Not enough traffic flow data is available, and what is received isn't used	We don't provide enough traffic management with the data we DO have (or could get; e.g., latitude and longitude for CHART devices). We need to do a better job of performance measurement and providing that information to travelers (e.g., 511, travel time displays).
With current resources we are significantly under-serving the	Some of the most severe and difficult incidents to resolve are those on roadways where there are few alternate routes, and the accessibility and maneuverability of response equipment is limited. This can often impact nearby arterials.

Case for Action Statement	Supporting Statements
public because we cannot collect data or provide full CHART capabilities on arterials, and are not able to provide enough traffic management.	The degree of congestion in the metropolitan areas has increased travelers' reliance on secondary roads as alternates. We need to provide adequate traveler information about these roads as well. If we do not provide more avenues for traveler "self-service" (e.g., 511, info on relative times on alternate routes), poor route decisions can and does result in increased congestion, increased incidents, congestion-related fuel waste and pollution, and increased cost-per-household.
We need strengthen our cooperation with our stakeholders.	We and our stakeholders have common elements to our missions and need to establish technical infrastructure requirements, common protocols and procedures (e.g., homeland security compliance) that we can all live with – CHART, SHA, MDOT, regionally, and nationally. We need to recognize that we cannot effectively fill the CHART mission without data exchange with other non-CHART organizations. If we allow stovepipes to crop up when funding is available for special projects, and we do not ensure that we allow for interfaces with new and future systems, we will perpetuate this problem. We need to recognize that that we can't (and shouldn't) do it all. If we don't say "no" to some of things we are asked to do (or agree to assist in some other way) we will continue to dilute our mission by trying to be all things to all people.
We need "teeth" in our agreements with non-CHART organizations and between CHART-related organizations.	The lack of clear, documented, supported agreements often results in errors, response delays and the "blame game." When responding to a highway condition-related incident where authority and accountability are unclear or conflicting, the responders may be confused about who's in charge, what should be done, and who has the clear responsibility AND accountability for making sure it gets done. Turf wars over device ownership and device sharing are counter-productive. Inadequate coordination between CHART, the signals group, and construction site managers during incidents sometimes results in resource inefficiencies and aggravated traffic situations. If we do not have clear agreements on day-to-day operations, we will certainly be at risk for poor emergency response (e.g., coordinating communications and activities across regions; Federal, State, and local agencies; and the private sector.

3.3 Vision

In response to the Case for Action, a vision of the future documents what the “to-be” CHART will look like. The key elements of the vision are illustrated in the picture below and detailed in the table that follows.

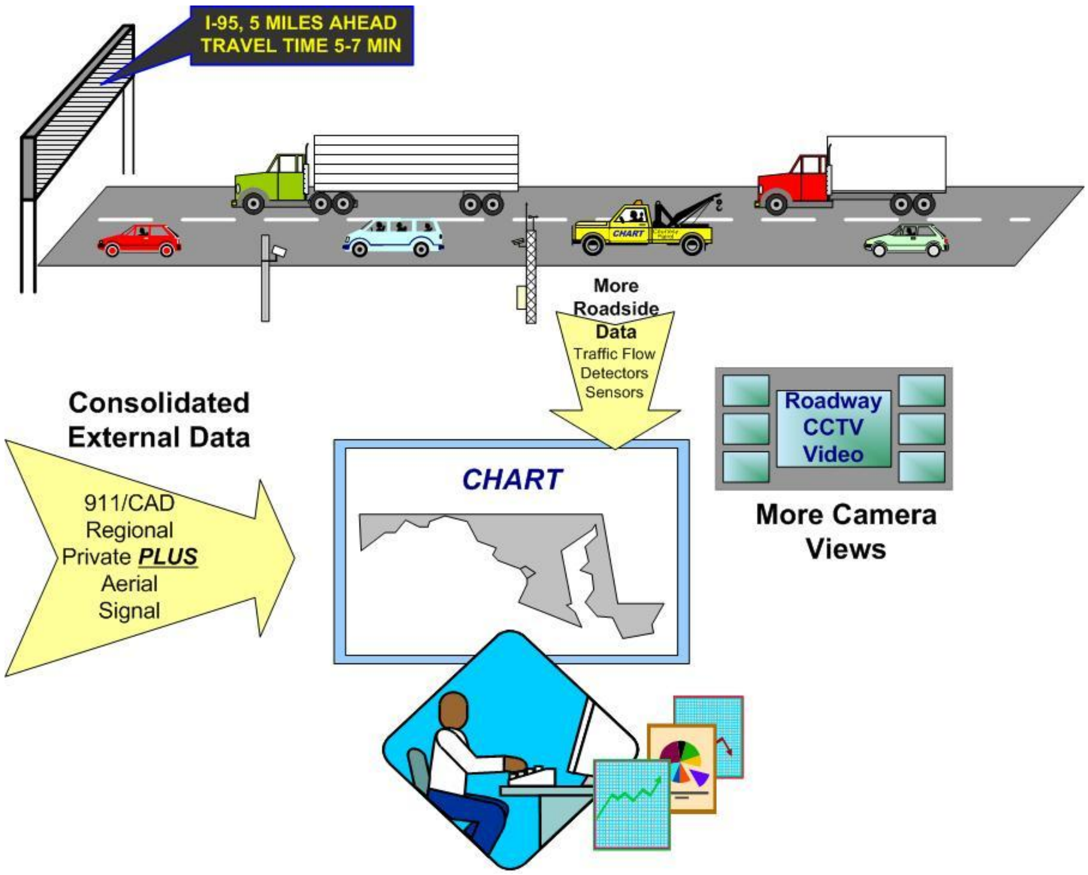


Figure 3.3-1 - CHART Vision Graphic

As the picture depicts in the center, the CHART operator of the future is no longer a Data Entry clerk with too much data input, but a Traffic Manager who is able to use processed traffic and incident information (e.g., trends) and fully integrated computer systems that provide consolidated data from numerous other sources (e.g., 911, regional data; and aerial data and signal data – that they didn’t have before). All of this information is provided seamlessly to the operator via one interface – CHART. Additionally new technology and communication methods facilitate more real time roadway data collection, and additional camera views provide more information to CHART operators. As a result of the newly integrated systems and data, more information (and of a higher quality) is provided to the traveling public (e.g., travel times on DMS), as is shown in the area at the top of the diagram. This, in turn, contributes to more efficient traffic flow.

While the graphic above symbolically represents some of the key elements of the Vision for CHART, specific vision statements (listed in the table below) were derived from workshops with CHART Users, Management, and Partners.

Figure 3.3-2 - CHART Vision Statements

POLDAT[1] Area	Statement
Process	***We will*** leverage technology and business arrangements to ***better support the CHART mission***
	CHART will monitor traffic and roadway conditions on all interstates and State roadways; and expand this coverage to arterials.
	CHART will provide operators, field responders, and the public with accurate, real-time information on roadway condition, incident activity, and congestion by broadcasting this information via multiple devices and formats, both pre-trip and enroute.
	CHART will provide all operators and field responders with the appropriate procedures and protocols so that they know, within 30 seconds of incident notification, what they need to know to respond to the incident.
	CHART will ensure that everyone traveling on roadways in Maryland has all the information they need to make good travel decisions.
	CHART services will arrive within 5 minutes to assist every stranded motorist and incident response in Maryland
Organization	***Better support CHART execution through alliances and system-supported job enhancement.***
	CHART will provide decision support tools that will allow operators to become traffic managers not data entry clerks.
	The cooperation between CHART and its key stakeholders will increase to the point at which: • CHART partners actively and fully support our agreements on procedures, protocols, and data sharing. • CHART systems will be fully integrated with other agencies such as VDOT, DDOT, DC, PENNDOT
Location	***CHART operations will all be virtual; our "office" is the State of the Maryland.***
	There will be a TOC in every District (starting with District 5 and the Eastern Shore
	CHART will expand to utilize existing signal systems to provide more capabilities and support to arterials/highways beyond interstates.
	CHART will better equip field operations to they can respond faster and more completely by providing field depots (closer to the field operations) to store equipment, provide shared office space for meetings, or even just a place to change a tire.
	CHART will provide 24 hour state-wide patrols.
Data	***Data from more sources; seamless to users***
	CHART will reduce the burden of determining what data may be required from other from other providers' systems be allowing them to provide simple data dumps and let CHART prescribe the filters for what CHART needs to know.
	CHART will be able to import/integrate external traffic data without operators knowing

[1] POLDAT = CSC methodology acronym for Process, Organization, Location, Data, Application, and Technology

POLDAT[1] Area	Statement
	or caring about the source (but it will be marked with the source so operators can gauge validity).
	The public regularly commutes across multiple jurisdictions and will neither know nor care "who is responsible" for notifying them of backups and cleaning them up. They will just get the information they need when they need it; irrespective of its source.
Application	***Increase usability, and more automation, integration, and intelligence.***
	CHART will provide incident management fusion such that the system: • Knows who needs what info and routes it appropriately (e.g., automatic notifications for fax and page, automatic "event [still] open" alerts with snooze). • Automatically keeps track of the age of the data (so users know what's current). • Supports standards-compliant intra-system messaging. • Automatically opens a CHART event with lane closures upon roadwork activation. • Provides an alert capability to let operators know when something needs their attention. • Provides automatic sign/DMS suggestions for major events based on location and direction. • Provides an event and device scheduler.
	CHART will integrate its systems and equipment with current systems and new external systems in support of reducing recurring and non-recurring congestion and increasing the safety of the traveling public. This includes, but is not limited to: • Providing regional integration with RITIS. • Integrating cameras with those of other agencies. • Providing automatic mapping, automatically programmable HARs and DMSs, automatic weather alerts, automatic paging, and automated incoming data collection. • Integrating AVL into CHART. • Providing traffic control signals status and monitoring. • Controlling lane use signals and traffic signal timing.
	CHART will be able to predict congestion and push response ***before*** it happens using location, time, current roadway conditions, weather, and other factors (e.g., prior incident patterns) based on historical data.
Technology	***More devices, smarter devices, field-accessible devices.***
	Information from CHART devices and sensors, and vehicles themselves will support automated incident detection and congestion detection, and will provide information (e.g., to the public via HAR, DMS and other) and to operators in order to divert traffic to uncongested areas.

	• To improve field operations capabilities and reduce response time, CHART will:
	  ○ Have sensor and camera coverage across the entire state highway system.
	  ○ Provide data and video to AND from field responders and management as appropriate. Examples:
	    • Provide field access (e.g., portable units) to CHART (e.g., for events, disabled vehicles, etc.) and agency resources (e.g., e-mail).
	    • Provide stationary but movable in/on-vehicle cameras (e.g., dash cameras mounted on the trucks that could even automatically take a

POLDAT[1] Area	Statement
	snapshot when the arrow-board goes up) • Provide detachable/mobile cameras and/or video equipment that are capable of transmitting images directly into CHART. • Provide better access to aerial assets to monitor traffic and relay/enter information (via on-board CHART).

3.4 High-level CHART Business Processes

Given the Case for Action and Vision documented above, the project team defined the new and modified business processes that must be in place (and supported by appropriate software) for CHART to fulfill the mission and goals described in Section 3.1. The new/modified processes they defined are listed below. Two key areas of change from the prior BAA are the importance of:

- Emergency Planning and Preparedness (including decision support tools, and simulation)
- Performance Management to monitor the effectiveness of the CHART program activities.

Several other more familiar processes have been enhanced through the specification of new high-level requirements for procedures, organizational structure and relationships, location, data, application, and technology.

The high-level business processes are shown in the diagram below. The diagram shows that all processes flow toward or support achieving the goal of mobility and safety for Maryland roadway users. The four core CHART processes (Monitor Traffic and Roadways, Manage Events, Manage Traffic, and Provide Traveler Information) are supported by the three enabling processes (Administer System and Equipment, Prepare for Events and Emergencies, and Manage CHART Performance). Each of these processes is summarized in the list that follows, and defined in more detail in the Business Process subsection of this document.

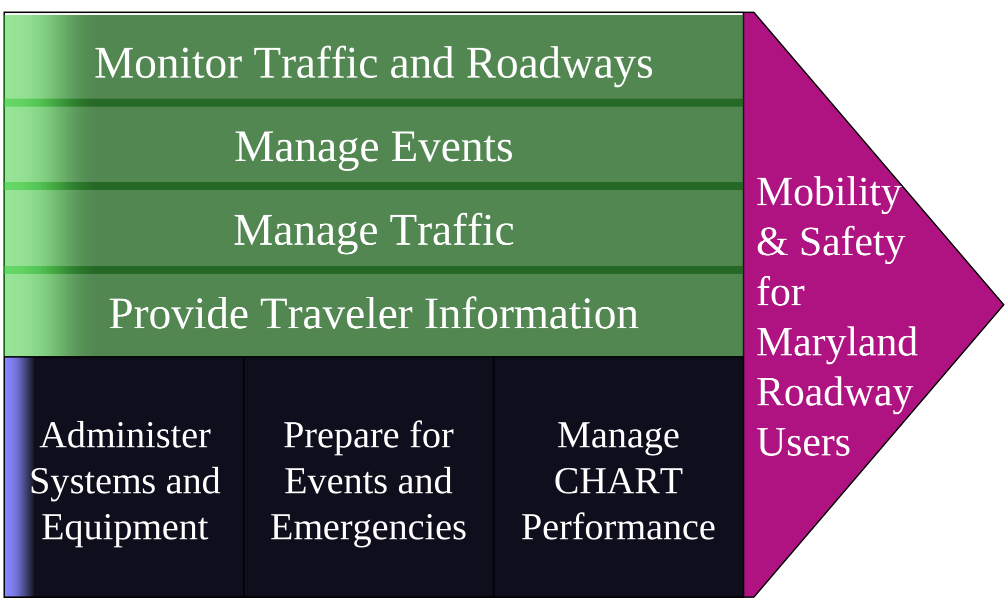


Figure 3.4-1 – CHART Business Processes

Administer Systems and Equipment - This process provides the means to manage system users and access (e.g., logins, shift handoff), define areas of responsibility, initiate updates to the map, manage the message libraries and dictionaries, and configure devices in the CHART system.

Prepare for Events and Emergencies - This process allows CHART users to determine, in advance, the recommended appropriate response to events and emergencies. It includes the ability to create decision support plans and simulate them, to associate traffic management plans to specific roadways (e.g., FITMs and alternate recommended routes) and to devices, to define criteria for system alerts, and to schedule events. Some of these capabilities existed in prior versions of CHART or were planned, but these new requirements provide more sophisticated capabilities and move these capabilities from the control of programmers to the control of CHART system administrators.

Monitor Traffic and Roadways – This process provides status on traffic and roadways and alerts operators to adverse conditions. This process includes detecting and recording conditions, issuing alerts and posting information, and receiving and responding to system alerts. Currently this process is mostly manual (e.g., camera observation; listening to scanners; reports from field operators, police and the public), but some automation (e.g., outputs from detectors) could be leveraged to automate more of this process. In the future, this process will automatically provide event alerts for CHART operators, and traffic management information for the public (e.g., travel times).

Manage Events - This process allows CHART operators to formalize an event; and initiate a response to events to optimize traffic flow on roadways and clear incidents and re-open lanes as quickly as possible, while protecting the safety of victims, travelers and emergency personnel. This process includes three basic steps for managing events:

1) Open the event (identify location, nature and severity of the event; leverage decision support tools to determine the course of action and deploy devices and resources).

2) Respond to and monitor the event (e.g., control on-scene and related arterial traffic flow using personnel and signals, perform scene activities, view cameras to monitor activities).

3) Close the event (e.g., verify the scene is clear, close the event in CHART or change the event type, notify appropriate parties).

Manage Traffic - This process leverages traffic flow data and CHART resources to manage freeway and arterial traffic flows with the goal of greater efficiency and safety. Better traffic management also allows CHART to do better incident management. Being able to improve traffic management on logical, diversionary, alternate paths is one of the biggest problems to overcome. However, CHART may have an advantage because currently many signals are managed at the state level (vs. local level) which could assist with the management of traffic. This process is primarily focused on non-event-related, recurring traffic conditions to prevent or relieve traffic congestion and balance traffic flow. It includes managing traffic flow through the intelligent use of signal control (based on both historical and current conditions), and providing traveler information on travel times and alternate routes.

Provide Traveler Information - This process provides real-time information concerning travel conditions on the main roads in the primary coverage area by broadcasting information to the public, providing camera feeds to approved agencies and partners, posting information on the public CHART website, providing CHART information directly to third parties (e.g., travel bureaus, the media) for dissemination to the public, providing recorded information on traffic and roadway conditions that is available via telephone. Traveler information focuses on planned or accidental traffic disruptions, such as accidents, chemical spills, snow, ice, floods, major special events, seasonal recreational peaks, and roadway construction.

Manage CHART Performance - This process allows CHART managers and others to assess and enhance the effectiveness of CHART by reviewing and evaluating the performance of devices, software, and personnel. This includes equipment failures or out of service status for maintenance, response time to events, etc. This process includes monitoring and reporting system operation anomalies (e.g., for devices, CHART software and hardware), generating statistical reports and analyzing performance, and developing recommendations for CHART improvement. Most of this process is done off line by CHART management and external industry analysts, but it is based on CHART data.

4 Business Process Model

The Business Process Model describes the to-be state of what CHART does, how CHART activities are carried out and in what sequence, what rules are followed, and the results of these activities. This is aligned with the Case for Action and Vision that guide the future focus of CHART. This section includes the Business Process Model Direction (Section 4.1), a high-level hierarchy of the business processes (Section 4.2), detailed definitions of the enhanced and new business processes (Section 4.3), the business performance goals that the new processes are designed to achieve (Section 4.4), and the business process recommendations (Section 4.5).

4.1 Business Process Model Direction

The Business Process Model Direction outlines the vision, and the principles, constraints, and assumptions that guide optimum operation of CHART activities and the application(s) that support them.

4.1.1 Business Process Vision

The key vision statement for the vision for the future CHART business processes, as described by the workshop participants is:

CHART will leverage technology and business arrangements to better support its mission

Specific examples of these goals are outlined below:

- CHART will monitor traffic and roadway conditions on all interstates and State roadways; and expand this coverage to arterials.
- CHART will provide operators, field responders, and the public with accurate, real-time information on roadway condition, incident activity, and congestion by broadcasting this information via multiple devices and formats, both pre-trip and enroute.
- CHART will provide all operators and field responders with the appropriate procedures and protocols so that they know, within 30 seconds of incident notification, what they need to know to respond to the incident.
- CHART will ensure that everyone traveling on roadways in Maryland has all the information they need to make good travel decisions.
- CHART services will arrive within 5 minutes to assist every stranded motorist and incident response in Maryland.

4.1.2 Principles

- CHART will establish clear protocols, automate processes and procedures (e.g., SOPs and FITMs) where practical, and leverage decision support tools for operations.
- The system will allow us to maintain and readily implement incident response plans.
- CHART will integrate SOPs with the software in a prioritized manner by order of importance.

4.1.3 Business Process Constraints

Some current agency policies and guidelines do not always address CHART's personnel issues and equipment regulations.

4.1.4 Business Process Assumptions

- SOPs will be applied consistently across all locations; the TOCs and SOC will have the same information and rules to perform system operations activities.
- The automation of processes and procedures will minimize data entry requirements for operators.

4.2 Business Process Hierarchy

Based on the previously defined Case for Action and Vision, the project team defined the new and modified business processes that must be in place (and supported by appropriate software) for CHART to fulfill the mission and goals described in Section 3.1. The new/modified processes they defined are listed below. Two key areas of change identified since the prior BAA are the importance of:

- Emergency Planning and Preparedness (including decision support tools, and simulation)
- Performance Management to monitor the effectiveness of the CHART program activities.

Several other more familiar processes have been enhanced through the specification of new high-level requirements for procedures, organizational structure and relationships, location, data, application, and technology.

All the high-level business processes are shown in the diagram below.

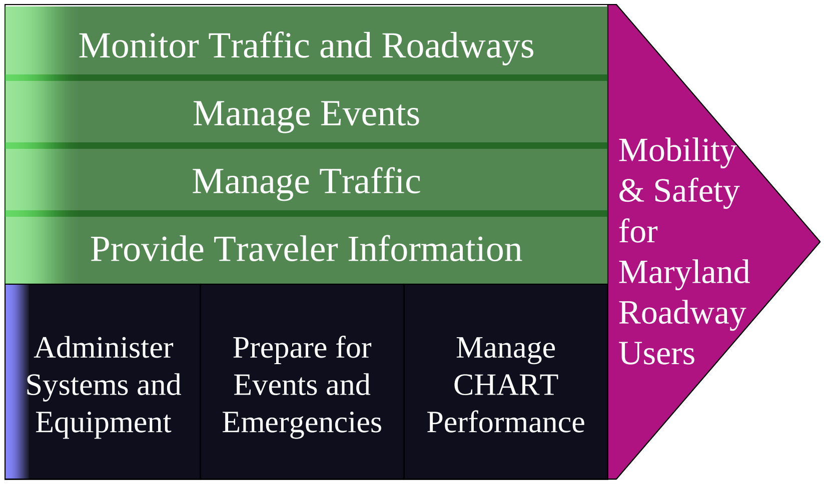


Figure 4.2-1 – CHART Business Processes

The diagram shows that all processes flow toward or support achieving the goal of mobility and safety for Maryland roadway users. The four core CHART processes (Monitor Traffic and Roadways, Manage Events, Manage Traffic, and Provide Traveler Information) are supported by the three enabling processes (Administer System and Equipment, Prepare for Events and Emergencies, and Manage CHART Performance). Each of these processes is summarized in the list that follows, and defined in more detail in the next subsection of this document.

Core Processes

Monitor Traffic and Roadways – This process provides status on traffic and roadways and alerts operators to adverse conditions. This process includes detecting and recording conditions, issuing alerts and posting information, and receiving and responding to system alerts. Currently this process is mostly manual (e.g., camera observation; listening to scanners; reports from field operators, police and the public), but some automation (e.g., outputs from detectors) could be leveraged to automate more of this process. In the future, this process will automatically provide event alerts for CHART operators, and traffic management information for the public (e.g., travel times).

Manage Events - This process allows CHART operators to formalize an event; and initiate a response to events to optimize traffic flow on roadways and clear incidents and re-open lanes as quickly as possible, while protecting the safety of victims, travelers and emergency personnel. This process includes three basic steps for managing events:

1) Open the event (identify the location, nature and severity of the event; leverage decision support tools to determine the course of action and deploy devices and resources).
2) Respond to and monitor the event (e.g., control on-scene and related arterial traffic flow using personnel and signals, perform scene activities, view cameras to monitor activities).

3) Close the event (e.g., verify the scene is clear, close the event in CHART or change the event type, notify appropriate parties).

Manage Traffic - This process leverages traffic flow data and CHART resources to manage freeway and arterial traffic flows with the goal of greater efficiency and safety. Better traffic management also allows CHART to do better incident management (e.g., ability to support alternate route designations). Being able to improve traffic management on logical, diversionary, alternate paths is one of the biggest problems to overcome. However, CHART may have an advantage because currently many signals are managed at the state level (vs. local level) which could assist with the management of traffic.

This process is primarily focused on non-event-related, recurring traffic conditions to prevent or relieve traffic congestion and balance traffic flow. It includes managing traffic flow through the intelligent use of signal control (based on both historical and current conditions), and providing traveler information on travel times and alternate routes.

Provide Traveler Information - This process provides real-time information concerning travel conditions on the main roads in the primary coverage area by:

- Providing camera feeds to approved agencies and partners
- Posting information on the public CHART website
- Providing CHART information directly to third parties (e.g., the media) for dissemination to the public
- Providing recorded traffic and roadway condition information via highway advisor radio, dynamic message signs, and telephone.

Traveler information focuses on planned or accidental traffic disruptions, such as accidents, chemical spills, snow, ice, floods, major special events, seasonal recreational peaks, and roadway construction. In the future this will also include travel times.

Enabling Processes

Administer Systems and Equipment - This process provides the means to manage system users and access (e.g., logins, shift handoff), define areas of responsibility, initiate updates to the map, manage the message libraries and dictionaries, and configure devices in the CHART system.

Prepare for Events and Emergencies - This process allows CHART users to determine, in advance, the recommended appropriate response to events and emergencies. It includes the ability to create decision support plans and simulate them, to associate traffic management plans to specific roadways (e.g., FITMs and alternate recommended routes) and to devices, to define criteria for system alerts, and to schedule events. Some of these capabilities existed in prior versions of CHART or were planned, but these new requirements provide more sophisticated capabilities and move these capabilities from the control of programmers to the control of CHART system administrators

Manage CHART Performance - This process allows CHART managers and others to assess and enhance the effectiveness of CHART by reviewing and evaluating the performance of devices, software, and personnel. This includes equipment failures or out of service status for maintenance, response time to events, etc. This process includes monitoring and reporting system operation anomalies (e.g., for devices, CHART software and hardware), generating statistical reports and analyzing performance, and developing recommendations for CHART improvement. Some of this process is done off line by CHART management and external industry analysts, but it is based on CHART data.

4.3 Business Processes Definitions

This section details each of the CHART business processes described above. It is presented in a numerically chronological manner, however, in day-to-day operation many of the processes occur simultaneously and/or in a different order. Within each subsection below the process titles are preceded with a parenthetical reference to the numbers on the business process model that was generated during the BAA workshops. These numbers correspond to the numbers in the upper left corner of each process box. For more information on how to read the process models and to see all the process model graphics, refer to Appendix A.

At the highest level, CHART is comprised of the seven major processes outlined in the previous section and shown in the diagram below. Each of these processes is described in more detail in the following sections.

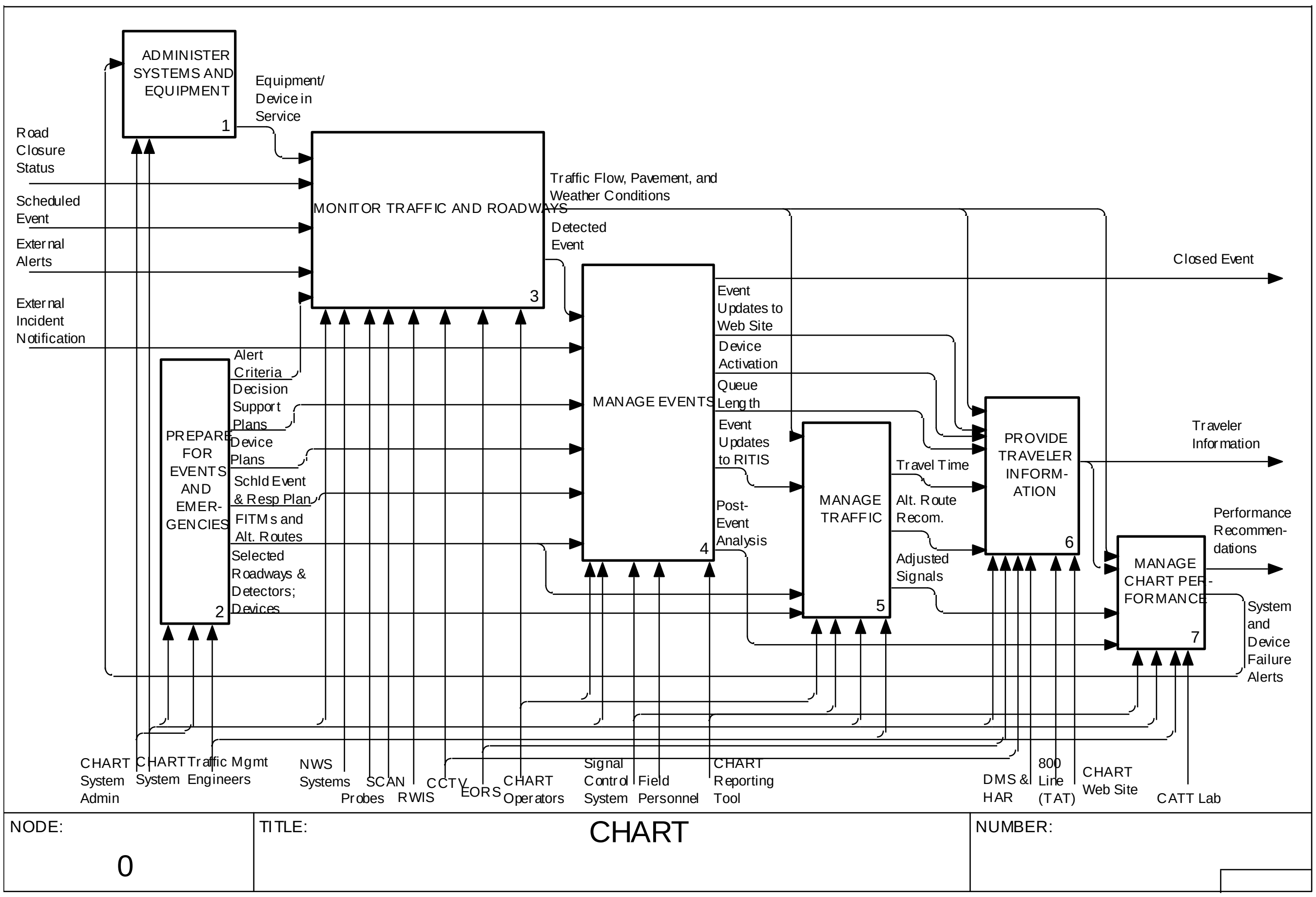


Figure 4.3-1 CHART Major Processes

4.3.1 ADMINISTER SYSTEMS AND EQUIPMENT

This process provides the means to manage system users and access (e.g., logins, shift handoff), define areas of responsibility, initiate updates to the map, manage the message libraries and dictionaries, and configure devices in the CHART system. It includes the sub processes listed below and shown on the figure:

- Administer CHART Organizations, Locations and Users
- Maintain Message Libraries
- Maintain Map
- Manage CHART Control
- Install and Maintain Devices

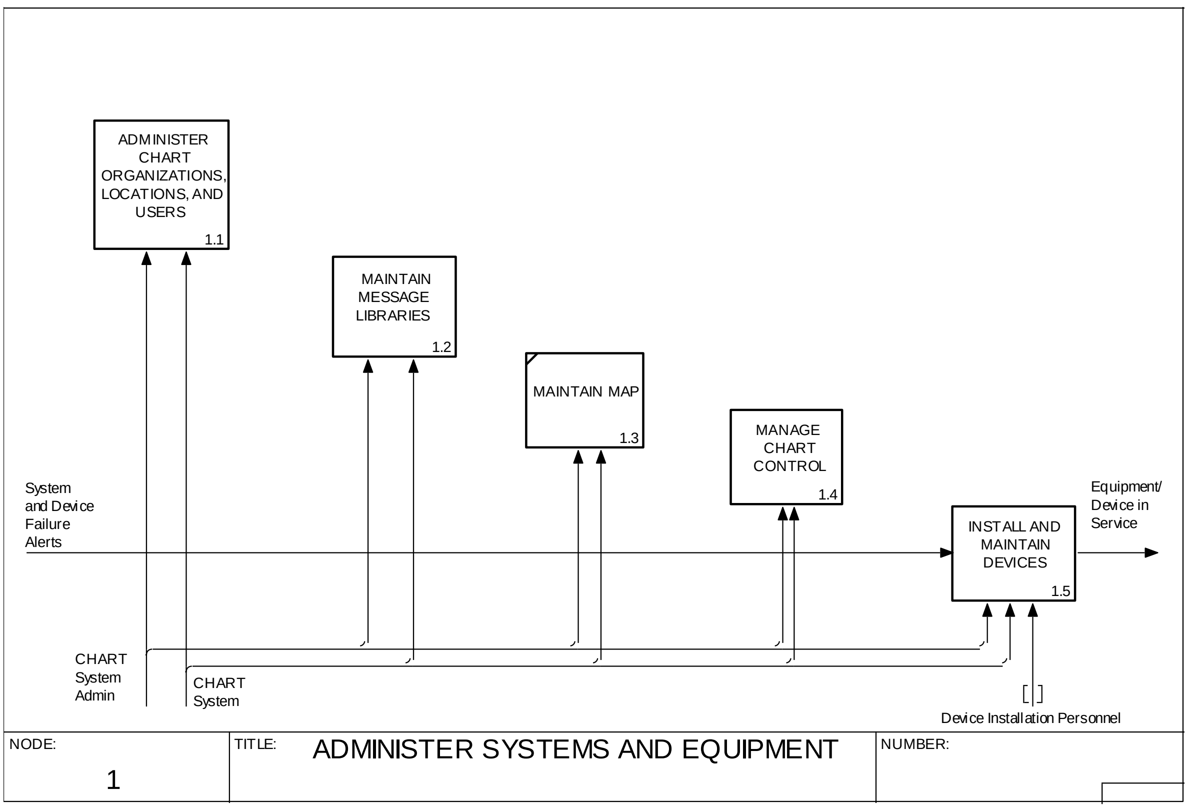


Figure 4.3.1-1 Sub Processes for Administer Systems and Equipment

(1.1) ADMINISTER CHART ORGANIZATIONS, LOCATIONS, AND USERS

(1.1.1) MAINTAIN CHART ORGANIZATIONS AND GEOGRAPHIC AREAS OF RESPONSIBILITY

This process allows for specifying types of locations and geographic areas of responsibility. The ability to identify these two items separately and associate them is a critical requirement, and facilitates more rapid identification of appropriate responders and organizations that need to be notified.

Currently the list of organizations includes a mixture of 87 different organizations; some are geographically specific (e.g., "Carroll") and some are type-specific (e.g., "Park Police"). Being able to identify the type of organization AND the geographic area of responsibility allows the system to automatically identify the correct resources based on the specific location of the event (e.g., closest maintenance shop, appropriate Maryland State Police (MSP) barrack, closest DMS), and to facilitate more granular management of requests for camera control. This facilitates both the current event management and the future decision support for event management.

(1.1.1.1) MAINTAIN ORGANIZATION TYPES

This process allows the system administrator to add, modify, or delete organization types. Examples of these types include TOCs, law enforcement, maintenance shops, media, etc.

(1.1.1.2) MAINTAIN GEOGRAPHIC AREAS OF RESPONSIBILITY

To leverage the map and let the system intelligently determine the areas of responsibility, this process allows the system administrator to determine, for each organization, the geographic areas of responsibility. The system administrator can add, modify, and delete the areas of responsibility. The current options would be "map-driven" (for most organizations, based on regional boundaries which by definition include county boundaries, and city boundaries), "state-wide/none" which would include state agencies or third party entities that have no specific geographic limitations, and "non-Maryland" which would include other states' geographies (e.g., northern Virginia and Delaware). Each area of responsibility should include a name and a brief description.

(1.1.1.3) MAINTAIN ORGANIZATION

This process allows the system administrator to add, modify, or delete new organizations from CHART. Examples would be a new TOC, a new CHART partner, etc. This process would require the following information:

- Organization name and short description of the organization.
- Association of the new organization to an organization type (e.g., traffic operations center, law enforcement).
- Association of the new organization to an area of responsibility.

(1.1.2) MAINTAIN CHART FUNCTIONAL RIGHTS

The ways in which rights, roles, and organizations are managed in CHART will need to be reviewed. Currently the system administrator cannot add, modify, or delete rights (it's code-driven). The administrator can only Set Rights for a specific role by associating/dissociating specific rights using check boxes. The rights (in some cases based on organization, too) determine what specific CHART features and capabilities can be associated with certain permissions. Examples are:

- "Basic" (view traffic event and view user logins)
- "Configure" (configure arbitration queue, configure system, configure users)
- "DMS" (configure, maintain), etc.

In the future, some of these rights might not need to be set because they would automatically be predetermined based on geography and organization; aka "Area of Responsibility." The area of responsibility would ensure that each device, sensor, etc. would be known and controllable from the closest, most appropriate CHART resource. Example: the "Manage Device Comms" right would not be necessary if/when the device had an assigned owner organization that has a defined geographic area of responsibility.

(1.1.3) MAINTAIN CHART ROLES

This process allows the system administrator to add a role, remove a role, or set rights for a role; and currently supports CHART's needs.

(1.1.4) MAINTAIN USERS

This process allows the system administrator to add a user, view and set the user roles (a user may have multiple roles), set the user password, and remove a user.

Currently, the user-organization associate occurs when the user logs in. CHART may want to consider moving to assigned organizations, depending on how area of responsibility, organization, and functional rights are integrated together. In the future, the system administrator may need to associate the user with an organization. The system administrator also needs a way to view the last time the user logged in to help identify potentially inactive users for further analysis; e.g., no longer an employee of SHA, and potentially a way to associate this user with their parent organization (e.g., employee of MdTA).

(1.2) MAINTAIN MESSAGE LIBRARIES

This process allows the system administrator to manage the dictionaries of acceptable and unacceptable words and phrases, create (and maintain) message libraries of prepared messages, and create (and maintain) templates of typical DMS and HAR messages (e.g., "Congestion at XXX, Exit YYY".

For all dictionary entries, message libraries, messages, and templates, there's a new requirement to display the userid and date/timestamp for when it was created and last used. This will greatly facilitate clean-up of out-dated entries.

(1.2.1) MAINTAIN DICTIONARIES

This process allows the system administrator to enter words and phrases into two dictionaries one each of acceptable and unacceptable words and phrases for use in DMS and HAR messages. The dictionary is used in validation of library and ad hoc messages for both DMS and HAR.

The current capability is not as robust as it needs to be. Examples:

- The acceptable word dictionary isn't helpful or used as much.
- Need more checks for commonly misspelled words
- Few users use the "edit automatic feature" because the rules do not currently address all situations.
- Many HAR messages include intentional mis-spellings in order for the pronunciation to be more precise so the spell-checking is not as useful here. Examples: "egzit" for exit, and "eye 90 5" for I-95.

Some possible improvements to consider are:

- Increased use of templates based on event type that have pre-defined phrasing for common message types to ensure more consistent verbiage (see process 1.2.3).
- Provide date/timestamps for dictionaries on when they are created and last accessed to identify entries that may not be useful and are candidates for deletion to keep the dictionary current.

(1.2.2) CREATE MESSAGE LIBRARY ENTRY

There are several user-defined message libraries. The library name indicates either an area of responsibility (e.g., "AOC", "District 3") or an event type (usually for state-wide or region-wide messages such as Amber alerts or state of emergency weather alerts). There are several naming conventions for these message libraries; enhanced capabilities for the naming and folder structure are needed.

Each message library can have one or more messages. Each DMS message includes:

- Message ID - unique identifier
- Message Name
- Message Text
- Topic/category (weather = Snow, Ice, Freezing Bridges, etc.)
- Sign length - maximum sign length
- Beacon indicator - flag indicating whether beacons are set on/off

Each HAR message includes:

- Header (agency broadcasting the message; usually SHA but can be MdTA or other)
- Body - of message
- Footer - radio call letters and frequency of specific HAR device

The messages are editable (e.g., change "exit" to "egzit" for better pronunciation of HAR messages), and may be deleted by the system administrator.

(1.2.3) CREATE DMS/HAR MESSAGE TEMPLATE

This process provides the ability to create standard templates for DMS (similar to the HAR templates that are currently available). This would include the standard formats for each type of DMS (e.g., for number of lines) and standard verbiage that includes generic information as placeholders. This could save time, increase accuracy and consistency, and minimize the training necessary to ensure that correct messages are displayed. These message templates could be used at any time, and the most appropriate message template would be invoked as part of the decision support (see process 4.1.2.3.3, "SELECT OR ENTER APPROPIATE MESSAGE").

(1.3) MAINTAIN MAP

This process allows the system administrator to: a) download the base map data, b) select and download applicable map layers, and c) modify map entries (e.g., for approved aliases of road names such as I-595, and d) add some key road intersections for county roads; CHART users currently rely on ADC maps for this data).

Currently this process is not automated and requires programmers to do the updates to the mapping system. The mapping/GIS data is obtained from HISD. A suggested improvement is to revisit the frequency and granularity that the GIS data is available from HISD, and additional data layers that may be available, CHART would like to have GIS data available from neighboring location, such as the District of Columbia, Virginia, Delaware, Pennsylvania, and better data for the bridges and toll areas.

(1.4) MANAGE CHART CONTROL

(1.4.1) CONTROL LOGIN

This process allows a user to select a center/location, and enter their user name and password in order to log on to CHART. This process also allows the system administrator to reset forgotten passwords. In the future, the system should allow single sign-on for log in to the CHART, the CHART map, the paging system, and EORS. Note: Login timeouts would have to be synchronized across applications. Additional security controls for number of login attempts before lock out and stronger authentication requirements should be considered.

(1.4.2) PERFORM SHIFT HAND-OFF (INCOMING)

This process allows a user to transfer control to another user (normally at shift change). The current capability to do this is satisfactory but improvements should include the capability for a system administrator to enter a pre-defined "message of the day" that would be displayed during shift hand off, requiring user to acknowledgement.

Once the initial login and shift hand off are complete, the Operations Center home page should display all the open events for that area of responsibility, by event type, and should allow the user to filter which event types to view. Additionally, open travel events for related areas of responsibility would be displayed. A suggested alternate arrangement of an enhanced Operations Center home page is provided in Section 8.3.1.1.

(1.4.3) MAINTAIN SHIFT HAND OFF REPORT

This process allows the user to enter notes and review other users' notes related to shift or Center activities. It is one continuous text field that is maintained by the users; e.g., old messages are deleted, messages updated/edited for accuracy. It is primarily used for operators to pass notes back and forth between shifts, and for supervisors to provide important information (e.g., Joe is out sick; call Jane instead).

This feature is very useful; everyone can see it and edit it so it promotes collaborative work. The feature is generally working well but needs a few more controls and could be more user-friendly. Examples of areas for improvement are:

- The user has to enter HTML commands to format content for text appearance and tables.
- It's too easy to accidentally delete data.
- There's no capability to automatically remove out-dated information; somebody has to delete it manually.
- Supervisors would like an acknowledgement that operators have read this.

(1.4.4) USE CHART CHAT

This process allows the users to maintain an on-line chat and is often used to facilitate inter-center communication instead of using the telephone. Not everyone uses the capability but it appears to be satisfactory at this time.

In the future, it might be helpful to have the message box pop up (or otherwise be more noticeable without interrupting on-going typing), and provide an audible alert when a message comes in and/or has not been checked (e.g., snooze timer).

Procedures for using CHART chat need to specify that this is an informal communication mode and shouldn't be used to send critical messages (e.g., related to urgent incident response).

(1.4.5) CONTROL LOGOUT AND TRANSFER CONTROL

This process allows the user to log out completely, transfer CHART control to another user (e.g., for shift change), and transfer resources (e.g., at the end of daily operations for Centers that aren't 24x7).

For transferring CHART resources, the system currently requires the events to get transferred one at a time or all at once, which works well. However, a new capability should be added for emergency log out and transfer procedures (e.g.., when a facility must be evacuated on short notice).

The system should not allow the user to log out completely or transfer resources without requiring him/her to check and/or update the shift hand off report.

(1.5) INSTALL AND MAINTAIN DEVICES

(1.5.1) INSTALL EQUIPMENT/ DEVICES

This process is primarily the responsibility of Planning, Engineering, and Maintenance organization. The key new requirement for CHART is to provide better coordination on the planned quantity and location of new equipment and devices, and to provide a capability of adding the device in CHART and on the map with a status of "planned" with an appropriate filter to make sure it isn't visible to operators (for planning purposes only).

The types of equipment/devices include:

- Dynamic Message Signs (DMSs)
- Highway Advisory Radio (HARs) and SHAZAMs (beacons)
- Closed Circuit Television (CCTV) cameras
- Point Detection (e.g., detectors for weather, environmental, and speed conditions, and snapshot cameras)
- Toll Tags Readers
- Cell Phones Readers
- Traffic Signals
- Vehicle Infrastructure Integration (VII) Readers
- Automatic Vehicle Location (AVL)
- Wireless Communication

(1.5.2) PUT EQUIPMENT/ DEVICES ON-LINE

This process allows users with appropriate rights to enter the device parameters, ownership, specifications, location, lat/long (future), area of responsibility, and the operational status. For cameras, this also includes defining tours, setting the CCTV presets and default position. The device is put in maintenance mode first, tested for communications with CHART, then put on-line in CHART. A separate map editing utility is used to place the icons on the map.

(1.5.3) PERFORM ROUTINE MAINTENANCE

This process is primarily done by maintenance personnel, and CHART Operators only know that it is not on-line (but not the reason for failure which often suggests when it might be available). The requirement is to integrate device maintenance web pages with CHART so the Operators could check on the device status, and know why it's not on-line (including the key trouble ticket information) and know the problem is being addressed.

(1.5.4) RESPOND TO EQUIPMENT/ DEVICE OUTAGE

This process is similar to routine maintenance since, but involves more parties because of the long-term outage of equipment due to external circumstances. This process also includes Operators responding to an outage that they have detected (or has been brought to their attention) by notifying maintenance personnel.

4.3.2 PREPARE FOR EVENTS AND EMERGENCIES

This process allows CHART users to determine, in advance, the recommended appropriate response to events and emergencies. It includes the ability to create decision support plans and simulate them, to associate traffic management plans to specific roadways (e.g., FITMs and alternate recommended routes) and to devices, to define criteria for system alerts, and to schedule events.

Some of these capabilities existed in prior versions of CHART or were planned, but these new requirements provide more sophisticated capabilities and move these capabilities from the control of programmers to the control of CHART system administrators.

This process includes the sub processes listed below and shown on the figure:

- Maintain Decision Support Plan
- Simulate Emergencies and Other Scenarios
- Maintain Traffic Plans (e.g., FITMs, alternate routes, devices)
- Define Alert Criteria
- Schedule Events

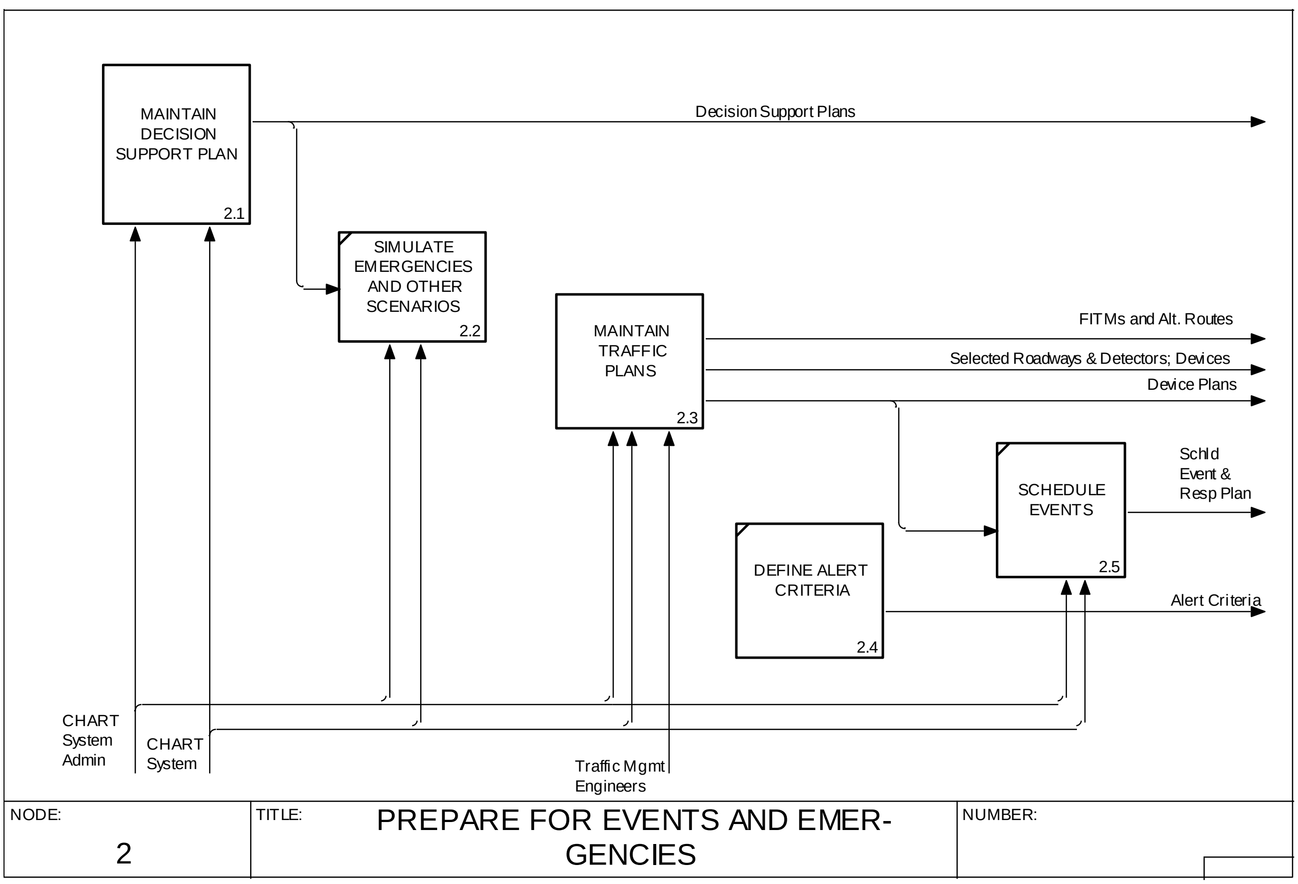


Figure 4.3.2-1 Sub Processes for Prepare for Events and Emergencies

(2.1) MAINTAIN DECISION SUPPORT PLAN

This process allows the system administrator to create, modify, or delete decision support plans by selecting an event type and set of conditions (from current event type list and conditions such as hazmat); and associating pre-defined response activities to that plan. The plan is location-independent; more specific information and recommendations are provided at the time of the event based on the specific geo-location of the incident.

The system shall capture userid and date/timestamps for plans on when they are created, modified, and last accessed to identify entries that may not be useful and are candidates for deletion to keep the plans current.

In the near future, while this capability is being developed, the decision support guidelines could be developed manually to enhance the current SOPs, and to provide a review and approval mechanism before putting the process into CHART. Example: Create a table that includes columns for each of the sub processes below. An example is included below.

Figure 4.3.2-2 Sample Format for Paper-based Decision Support Procedures

Decision Support Plan Name	Conditions*	Devices**	Resources and Notifications***	Check for FITM/ alt route	Reviewed by
Major Accident	*Event* = Incident *Lanes* = 75-100% of lanes closed	All devices within 0-3 and 4-10 miles	MSP, MEMA	Yes	DSmith
Disabled Vehicle	*Event* = Disabled Vehicle *Lanes* = < 25% of lanes closed	Cameras within 0-3 miles	MSP (optional), tow company	No	DSmith
Accident with PI and hazmat	*Event* = Incident *Lanes* = < 50% of lanes closed *Special* = hazmat and PI	DMS, cameras, and monitors within 0-3 miles	MSP, MDE, etc.	Yes	DSmith
Ravens Game	*Event* = Special Event *Lanes* = 0 lanes closed	DMS and HAR within 0-3 and 4-10 miles	n/a	No	DSmith

* (Event type, lanes closed, special conditions)
**(DMS, HAR, camera, monitor, signals)
***Includes external agencies, SHA resources (e.g., shop, ERT), equipment (e.g., front-end loader), other organizations (MSP) plus message (e.g., "Request on-scene response" "FYI")

A long-term future enhancement would be to make these procedures self-learning. For example, it could capture data on previous incidents and make recommendations for a current incident.

(2.1.1) NAME DECISION SUPPORT (DS) PLAN
This process allows the user to enter a decision support plan name and brief description.

(2.1.2) SELECT DS PLAN CONDITIONS
This allows the user to select an existing event type and set of conditions (e.g., hazmat, number and types of vehicles, number and nature of injuries, detour/FITM required, day of the week and time of day, vehicle jack-knifed, or other significant conditions).

(2.1.3) ASSOCIATE DEVICES TO DS PLAN
This process allows the user (typically the system administrator who is creating the plans) to select the types of devices and range (proximity) of devices that should be used for the selected event type and conditions. Examples of devices include: DMS, HAR, SHAZAM, camera, monitors, and signals. Examples of ranges include 0-3 miles, 4-10 miles, 11-50 miles, etc. All device activation would be based on the associated area of responsibility relative to the event location. Key business rule: The more lanes are closed, the farther back the DMS should go.

The process should allow the user to enter (or select and edit from the message library) the message (or template) that should be used for the applicable devices type(s) when the decision support plan is activated. It should also allow the user to set the device activation timing (e.g., to allow for a start-time delay if the device is being configured for the staging phases of an event; to provide a stop time alert for recovery from an event).

(2.1.4) ASSOCIATE NOTIFICATIONS AND RESOURCES TO DS PLAN
This process allows the user to review a predefined list of resources such as agencies, SHA resources (e.g., shop, ERT), equipment (e.g., front-end loader if the incident involves an overturned truck), and other organizations (MSP, medivac, private tow company, etc.); and select those who should be notified only and those who should be contacted to coordinate response activities. It should also include, for each resource, when they should be notified/contacted and what additional message (if any) should be sent. The message should be able to be associated to multiple resources without having to copy/paste.

A key issue with this requirement is that asset management at the shop level is not currently done, so it is not possible to know which equipment is at each shop. The requirement for maintaining equipment inventory has already been documented.

(2.1.5) ASSOCIATE FITM OR ALTERNATE ROUTE
The process allows the user to select whether or not the system should check for the existence of a known FITM plan or alternate route for the roadway, based on the incident type and location. Example: This option would be selected if the incident type were a major accident with multiple lane closures but would not be selected for a disabled vehicle.

(2.1.6) SET DS PLAN STATUS

This process allows the system administrator to set the status for a decision support plan as it goes through a review lifecycle since review, testing and simulation, and approval are required before a DS plan should be presented to an operator.

(2.2) SIMULATE EMERGENCIES AND OTHER SCENARIOS

Per the workshop, a key element of qualifying the plans is testing via simulation based on detectors that capture real-time traffic flow. This is primarily a task for the University of Maryland. This allows prediction of the best routes for alternative traffic flow (e.g., this route will take 1 hour; this other route will take 1.5 hours). More information on simulation is provided in process 7.4 “SIMULATE CHART OPERATIONS AND TRAFFIC MANAGEMENT”

(2.3) MAINTAIN TRAFFIC PLANS

This process allows the user to create, modify, and delete FITMs and alternate routes, and device plans. The ability to see the current detour information on the web site is potentially critical traveler information; it can be map-based (e.g., actually see the recommended route in another color) or text-based (e.g., just the text of the route information).

(2.3.1) MAINTAIN ROADWAY PLANS - FITMS AND ALTERNATE ROUTES

This process allows the user to enter and associate pdf files of FITMs to specific roadways in CHART, and to specify alternate routes for specific pre-defined evacuation plans or routine traffic management.

For FITMS: In the future, the users would be able to view the master [read-only] FITM, modify it for use during an incident, and update it as conditions change for that incident. In the future this capability would be fully integrated with the map so that the user could see the road closure and detour. Example: View the FITM, modify for current use if necessary, click "Activate FITM" and the map updates to show an overlay with the activated DMS and the detour route. When the event is over, click "Deactivate FITM" and it's removed from the map view and it goes back to normal.

An option for an interim solution is to allow the user to click on or roll over the FITM icon on the map and have the text of the FITM pop up.

For Alternate Routes - Major Incident-Evacuation**:** Currently there are several approved evacuation plans (two to four each for the Eastern Shore, Calvert County, St. Mary's County, Charles County, etc.) with more in the draft and approval stages (e.g., for Bay Bridge; evacuation of the DC area, Baltimore area, Annapolis area). The evacuation routes should be associated with evacuation plans (and associated devices and messages) within CHART. Note: The regional plans should only be accessible to users with the appropriate rights.

For Alternate Routes - Routine Traffic Management. The capability discussed above is desired for recommended alternate routes to better manage traffic flow due to an event (vs. the FITMs or evacuation plans which are used when traffic *must* be re-routed).

Related issues:

- Most FITMs exist only in hard copy. Only recently reviewed and approved plans are in the system. The approval cycle for new FITMs can be long since it involves other groups.
- FITMs are required for all interstates but many are outdated.
- CHART would like to have appropriate level of visibility into military evacuation plans (e.g., Aberdeen Proving Ground).

All plans would capture date/timestamps and userid based on when they are created, modified, and last accessed to identify entries that may not be useful and are candidates for deletion to keep the plans current.

A recommended future enhancement is for CHART to dynamically create alternate routes and detours as a feature of the decision support plans.

(2.3.2) IDENTIFY ROADWAYS FOR SIGNAL CONTROL AND TRAVEL TIME

This process allows the CHART system administrator (in consultation with traffic management engineers) to specify which roadways are to be monitored for specific traffic management purposes. Although much roadway data is collected for statistical purposes and for event-related activities, this process allows the user to select a subset of roadways for which data will be analyzed.

This process allows the user to select specific roadways and specific traffic flow/speed detectors on those roadways; and designate them as key data points for traffic and roadway management. It also allows the user to relate the detectors to each other (e.g., four speed detectors along the same roadway), define the threshold for issuing a signal control or alternate route recommendation, and define the action or devices to be activated if/when these thresholds are reached (or post the data directly, in the case of travel time calculations).

This process also allows the user to associate the selected roadways and detectors with specific devices that can be used to manage the traffic (e.g., specific signals for signal control, and specific HARs, DMSs, and CHART website for alternate routes or travel time messages).

(2.3.3) MAINTAIN DEVICE PLANS

This process allows the system administrator to create, modify, and delete device plans. This includes the pre-planned devices and corresponding specific messages for known and likely events (e.g., Raven's games, Amber alert, safety alerts and public service announcements, Bay Bridge high wind warnings, major delays on 895).

Currently there are over 300 plans that are accessible via advanced sort and search.

When creating plans, the user can select one message and assign it to multiple devices. Also, there needs to be clear, documented business rules and templates for the standardized wording of messages.

When maintaining plans, a key new feature is to allow a user to add a new device to one or more plans based on area of responsibility.

When creating or maintaining plans, the system captures date/timestamps when last accessed to identify entries that may not be useful and are candidates for deletion to keep the plans current.

(2.4) DEFINE ALERT CRITERIA

This process allows the system administrator to define alert conditions and appropriate notifications based on the responsible Center. Many of the requirements for this area were initially defined several years ago (see CHART requirements 3.1.2.22.1.1 through 3.1.2.22.1.15; and the 2000 version of the BAA, Section 2.2.4.5.2). However, some alert types have changed. The currently defined alert types (as validated in the BAA workshop) include:

- Action from open report
- Device failure
- Equipment request from open report
- Incident from open report
- Incident from detector
- Incident or event from external source (e.g., EmNet Amber Alert)
- Incident from field unit
- Disabled from field unit
- Mayday from AVL
- Congestion from detector (low travel time, low speed)
- Weather alert (from NWS via EmNet or SCAN)
- Weather sensor
- CHART Infrastructure failure (service failure; e.g., AOC is down, does the SOC want to transfer resources?)

Note: The requirement for the Delinquent Equipment Status was deleted during the workshops.

Five new alerts were suggested:

- For special permit vehicles (e.g., wide and/or heavy load, hazmat) approaching construction area with limited lanes and/or approaching incident.
- For out-of-tolerance sensor/detector values (e.g., to alert the operator to potential equipment problems; this is an expansion on the device failure alert requirement).

- For congestion detection based on signal traffic counters (this was partially noted in the original BAA).
- For calculating and displaying queue length updates for an incident.
- For Center-to-Center alerts from external systems (e.g., Homeland Security alert)

In keeping with the key principle to allow the system to be less code-dependent and more user-configurable (i.e., usually system administrator), the key new requirement is to have the alerts be defined by the user as much as possible.

Key issue: CHART will need to carefully define "normal" for each roadway area/time, and work with industry standards and CHART roadway experience to carefully define "congestion."

(2.5) SCHEDULE EVENTS

This process allows the system administrator to schedule events and corresponding response plans in the system before they occur. Many of the requirements for this area have been defined and are summarized below.

- Be able to schedule specific events and assign device plans to them (example: Bay Bridge Walk).
- Be able to schedule multi-day repeating events (and device plans); e.g., 3-day jazz festival, week-long nightly Wilson Bridge construction, or entire season of Ravens scheduled home games. This allows the user to create the response plan once and assign multiple, separate start/stop times for the event/s.
- Be able to specify the alert timer (e.g., issue alert to operator 15/30/60 minutes prior to planned event activation).
- Be able to have EORS supply the key information for planned roadwork.

4.3.3 (3) MONITOR TRAFFIC AND ROADWAYS

This process provides status on traffic and roadways and alerts operators to adverse conditions. This process includes detecting and recording conditions, issuing alerts and posting information, and receiving and responding to system alerts. Currently this process is mostly manual (e.g., camera observation; listening to scanners; reports from field operators, police and the public), but some automation (e.g., outputs from detectors) could be leveraged to automate more of this process. In the future, it is desired for this process to automatically provide event alerts for CHART operators, and traffic management information for the public (e.g., travel times).

This process combines input from the following sources to provide the information necessary to assess real-time traffic flow.

- Traffic speed detectors provide the average speed of traffic flow along a segment of roadway for early detection of traffic congestion and incidents, and can provide data to calculate travel times.
- Video verification provided by Closed Circuit Television (CCTV) cameras provides visual information on traffic congestion, disabled vehicles, incidents, and roadway conditions, and inclement weather.
- The #77 cellular call-in system allows individual motorists to report disabled vehicles and accidents.
- Scanners and probes detect and identify traffic anomalies.
- Reports from field units including State and local police, SHA field units, other state and regional agencies, and commercial radio traffic spotters who operate from aerial as well as ground units.
- Pavement weather sensors provide pavement temperature, moisture, and degree of chemical treatment during winter operations.

There are many initiatives -- both technology-related and not -- that the workshop participants suggested be pursued in this area. Examples include:

- Could we be doing more with the data we already have? Can we do travel times with our detector data (proactive traffic management, automated queue detection, incident avoidance, and traveler information)?
- Could we get more data from other public and private partners?
- Could other SHA organizations use our data to more effectively support their missions? Just because they haven't asked for our data yet, doesn't mean that they might not need it.
- What capabilities could be added to the CHART cameras? Example: Could we use them to detect non-moving traffic like a stalled vehicle on the shoulder?
- Could we use some of infrastructure (e.g., power) at abandoned sites (e.g., where the old Whellen detectors were) for some new capabilities or detector types?
- How could we tap into the aerial media for increased spot accuracy?

In terms of incident prevention, optimizing traffic flow, and, accurate traveler information, there is no more fundamentally important process than traffic and roadway monitoring. Federal legislation recognizes this -- Safetea Lu requires each state to have a robust traffic monitoring system. Based on the criticality of this process, and since many of the ideas listed above are based on leveraging existing capabilities, a clear statement from the workshop participants was "less white papers, more action on already identified alternatives."

For the purposes of identifying the specific requirements for traffic monitoring, this process includes the following sub processes which are shown the figure below, and described in more detail in the paragraphs that follow.

- Detect Conditions
- Record Conditions
- Issue Alert or Post Information
- Receive and Respond to Alert

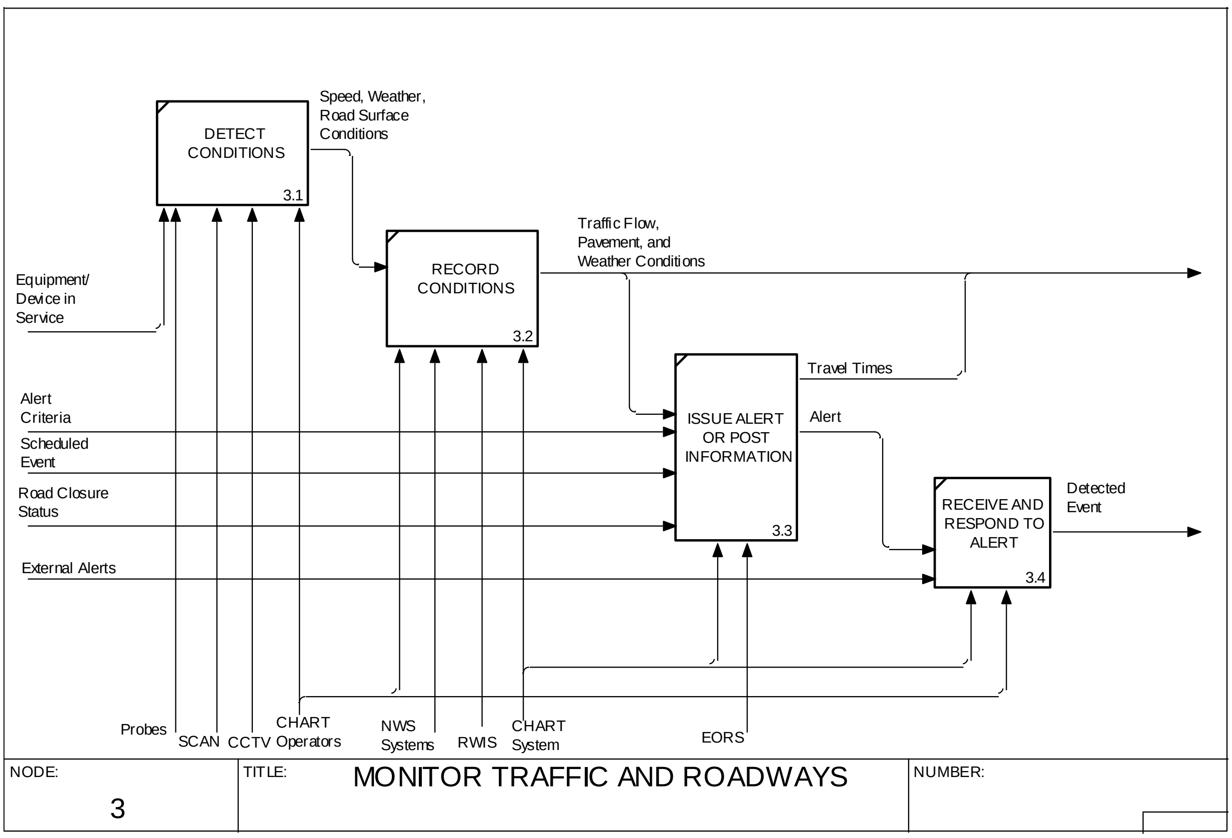


Figure 4.3.2-1 Sub Processes for Prepare for Monitor Traffic and Roadways

(3.1) DETECT CONDITIONS

This process involves the sensing of traffic and roadway conditions. It is performed by devices (e.g., sensors, detectors, probes) and human beings who are monitoring conditions (e.g., TOC operators watching cameras, answering phone calls from the police and public, listening to scanners; and personnel in patrol vehicles).

In the future, new sources for detecting conditions can be used such as motion detectors attached to cameras (currently in place in MdTA tunnels); toll tags, GPS on commercial vehicles, and cell phones as probes, non-SHA detectors from private parties, non-CHART SHA detectors (e.g., from signal shop, HISD, from MMTIS). For more information on new devices and technology, refer to Section 9.

(3.2) RECORD CONDITIONS

This process captures the detected conditions in an electronic form. This is mostly for detectors, sensors, and probes that automatically send their data to the CHART database when they are polled or send their signal, but also includes CHART operator notes in the communications log advising of conditions that have the potential to become events such as recording the verbal notification from scanners and phone calls.

The recorded data from detectors and sensors is automatically sent to the archive after the pre-determined time.

(3.3) ISSUE ALERT OR POST INFORMATION

This process determines whether or not an alert should be issued to the appropriately designated CHART operator (or other resource) that he/she should consider some specific action (e.g., open a new event, close an on-going event for which there has been no activity for x minutes, issue request for maintenance on a detector). The system could do this by:

- Comparing the recorded data and analysis against the alert criteria (e.g., thresholds, historical data). If the alert criteria are satisfied (e.g., roadway speed < 50% normal flow), then the system will issue an appropriate alert (e.g., congestion event warning, signal timing warning, wind warning or restriction).
- Comparing the timing for scheduled events (e.g., construction setup from EORS, Ravens game) to the system clock. This may require additional confirmation or checking to make sure the event is still scheduled to happen.
- Comparing lane closures (incident based) or lane-narrowing (construction permit based) with permits in EORS for wide/heavy loads to alert and/or divert the vehicle from an incident or a limited lane area.
- Performing calculations on pre-defined sets of current data to display information to operators or the traveling public (e.g., posting speeds, calculating queue length for incidents, calculating travel times and displaying them on pre-defined DMS).
- Comparing current data to a pre-defined acceptable range of data to identify potential equipment anomalies (e.g., speed = 200 mph, roadway temperature significantly different from other nearby detectors or from same detector within the last x time period).

Important business rule: The number and types of alerts needs to be carefully considered so the users aren't bombarded with alerts.

The method(s) of alerting the users will be further defined during design but could include a visual or audible indication to the CHART user, and/or updates to the map (such as a blinking incident/event icon).

(3.4) RECEIVE AND RESPOND TO ALERT

This process allows the user to review the alert and determine whether or not to accept the alert, delay the alert, or reject the alert. There will need to be appropriate logic to ensure that when the alert is rejected the system does not keep sending a new alert (e.g., "Don't remind me" with a pre-defined time limit).

There is a new requirement to be able to receive and send alerts from/to external systems. Examples include alerts coming through Center to Center external interfaces (e.g., Homeland Security alerts, private traffic service, CAD 911 or some feed from RITIS) related to incidents or events that have the potential for affecting traffic or roadways within CHART's purview (or CHART incidents or conditions that could affect others). More detailed definition of these requirements will address the types of filters that would apply, and ways to verify acknowledgement.

Important business rule: There should be no automatic event initiation; only suggestions on which the operator may choose to act.

4.3.4 (4) MANAGE EVENTS

This process allows CHART operators to formalize an event; and initiate a response to events to optimize traffic flow on roadways and clear incidents and re-open lanes as quickly as possible, while protecting the safety of victims, travelers and emergency personnel.

CHART utilizes events to identify and organize data related to each activity performed by the operations staff and field responders. Each event includes data identifying the operational center managing the event and event-level data including the start/end times and status of the event. Any activity related to an event is recorded as part of the event (DMS, HAR, alerts, notifications, etc.).

There are three basic steps (sub processes) for managing events, as shown in the figure below:

- **Open the event** (identify location, nature and severity of the event; leverage decision support tools to determine the course of action and deploy devices and resources),
- **Respond to and monitor the event** (e.g., manage on-scene and wider area traffic flow using personnel and signals, perform scene activities, view cameras to monitor activities), and
- **Close the event** (e.g., verify the scene is clear, close the event in CHART or change the event type, notify appropriate parties).

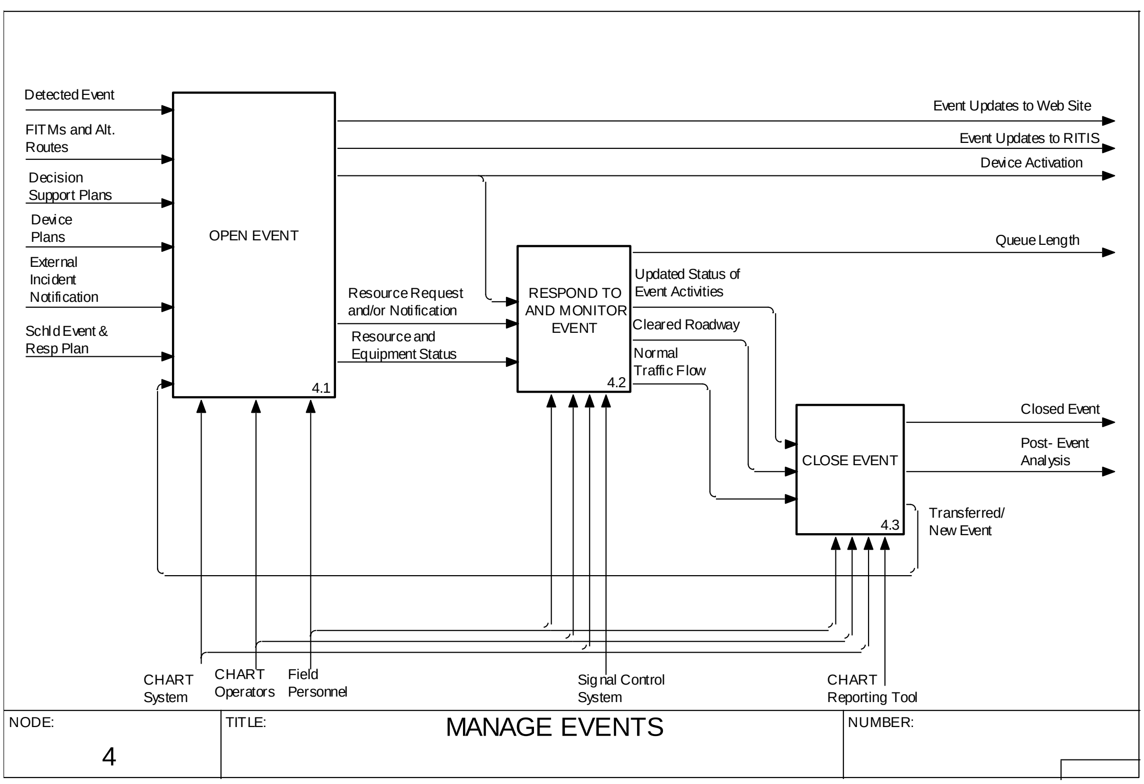


Figure 4.3.3-1 Sub Processes for Manage Events

The tools used for event management include:

- Field response units to set up overall traffic control at accident locations.
- Freeway Incident Traffic Management (FITM) Trailers, pre-stocked with traffic control tools such as detour signs, cones, and trailblazers are used to quickly set up pre-planned detour routes when incidents require full roadway closure.
- A "Clear the Road" policy which provides for the rapid removal of vehicles from the travel lanes rather than waiting for a private tow service or time consuming off-loading of disabled trucks which are blocking traffic.
- Coordinated detection, verification, and response using multiple methods for exchanging information with other incident management agencies.

A variety of other tools are used to facilitate event management. These include portable arrow boards and portable variable message signs for traffic management; front end loaders, tow rigs and push bumpers to move vehicles; and training exercises to maintain a high competency level for teams working under hazardous conditions.

(4.1) OPEN EVENT

This process allows the user to capture event details and initiate the appropriate event response actions to deploy resources and notify affected parties.

(4.1.1) RECORD EVENT DETAILS

This process allows the user to record event details. Currently the system requires that the user first select an event type which then invokes a series of screens to make selections. A suggested enhancement is to modify the order of the selections (in accordance with the sub processes below) to allow the user to capture all relevant details without having to select a specific event type immediately.

(4.1.1.1) SPECIFY LOCATION AND IMPACT

This process allows the user to specify the location of an event and the impact (e.g., lanes closed, number of vehicles involved). If the event is being initiated as part of a confirmed alert of a detected condition, then the location data and possibly much of the specifics could be automatically populated (e.g., CHART vehicle AVL/GPS location data for an AVL alert).

Event initiation and location data can be received via:

- Phone reports from field units, other TOCs/AOC, municipalities and other DOTs, the traveling public, other traffic officials.
- Operators observing CCTV monitors, listening to the scanner, viewing data from the police teletype.
- Confirmation of a system-generated alert of a detected incident.
- Notification from an external electronic source (e.g., MEMA, CAD 911, NAWAS/WAWAS).

If the user is entering the location data, there should be at least two ways of entering the data. This suggested enhancement would make the data more consistent, and limit the use of free-form text. The entry suggestions are:

- **Map-based event location**. Using the map, click on a segment of road and check for lanes. The system should automatically display the lane configuration default.
- **Pulldown menus for pre-defined roads**. The user would select a county, select a roadway type from pick list ("I" "US" "MD"), select a route number, and select a intersecting or identifying roadway relationship (prior to, past, exit/entrance number, intersection). (Done)

If the location information is coming in automatically, the user still needs to be able to edit the information. Example: Automatic GPS location from the field unit detector (AVL) may pre-populate the location data, but the unit may be on a different loop/direction from the incident.

The impact information needs to include the number of roadway lanes affected (system needs to display the correct lane configuration for that facility or stretch of roadway including two-way traffic on tunnels, bridges); and any other special conditions (e.g., weather, hazmat) that are pertinent (specifics to be determined during redesign).

(4.1.1.2) CAPTURE DAY/DATE/TIME

This process automatically captures the day, date, and time of the event as soon as the event is opened, and the location and impact data are known.

Note: Day of the week is important for analyzing statistics (e.g., weekdays vs. weekends). This may be able to be calculated off-line by some routine vs. built into CHART.

(4.1.1.3) CAPTURE WEATHER CONDITIONS

This process automatically captures the environmental and roadway conditions from the closest sensors as soon as the event location is known. The specific number of sensors and determination of "closest" will be defined during design.

(4.1.1.4) IDENTIFY EVENT SOURCE

This process captures the source of the notification of the event. This will be pre-populated automatically for any of the automatic/electronic sources (e.g., detected event from alert, automatic feed from RITIS). If it is not pre-populated, the user must select the source type from a pre-defined list. The source is important information for the operators to determine the validity or trustworthiness of the reported event, and for longer term statistical analysis.

(4.1.1.5) CAPTURE RELATED EVENTS

This process automatically checks to see if the new event is similar geographically and/or by type to an existing event. If it is, the system displays the similar event's title and description (and allows the user to view additional details about it), and allows the user to delete or merge the new event (duplicate), or associate the events (e.g., for roadwork, other incidents, special events, water main break, weather).

There is a “merge event” capability for those cases where devices are being used by different centers. Example: Currently TOC 4, AOC, and SOC all open events related to the Bay Bridge walk. CHART ensures that these events are counted correctly for statistical purposes (that is, no double-counting, or under-counting).

(4.1.1.6) SPECIFY NATURE OF PROBLEM

This process allows the user to capture additional details that help determine the severity and type of event, and any additional special conditions. There are at least three primary aspects to this: Vehicle Type/Count, Incident Type, and lanes affected. The current list in CHART is fairly expansive and should be validated during any scheduled enhancement to this capability.

(4.1.1.7) DETERMINE EVENT TYPE

This process allows the user to select the event type. This step will exist at the appropriate time in the process of entering the event. A number of examples of the inability to enter key data until the event type was determined the event type were discussed as a part of the workshops.

(4.1.2) DEPLOY RESOURCES

This process allows the operator to assess the event details and determine the appropriate resources to respond to the event. It includes verifying the initial event information, using the pre-defined decision support plans to suggest the course of action and notifications, and executing the selected (or modified) course of action (e.g., activating the appropriate devices, notifying responders).

(4.1.2.1) VERIFY EVENT LOCATION AND SPECIFICS

This process provides the ability to verify the location and incident specifics in order to ensure that the event is valid and to determine its full extent. The user verifies and captures additional details such as location/direction, lanes closed, what's involved in terms of injuries, vehicles, damage, hazmat, etc. The purpose of this is to determine the most appropriate course of action, based on input from the scene (e.g., dispatch unit, field personnel, CCTV) or from a trusted source (e.g., law enforcement).

As soon as the event location and specifics are verified and the event is opened, the data goes directly to the web page and RITIS (University of Maryland) which will (in the future) update WebEOC.

(4.1.2.2) EVALUATE EVENT RESPONSE RECOMMENDATIONS

This process provides the ability to review and evaluate recommendations for event response generated from pre-defined decision support plans and the event data. Based on the event type and conditions and location, the system displays the most appropriate corresponding recommended response plan.

The user reviews the recommendations and assesses regional impact, offers suggestions, and records the event response decisions. Specifically, the user:

- Reviews the recommended device usage and the corresponding message/control; and accepting, editing, or bypassing these recommendations.
- Reviews the recommended resources for response or notification only (to whom) and corresponding message.
- Reviews the recommended SHA response equipment.

For transferred/new events (e.g., an incident event that is now a congestion event), the system should display the prior response actions in progress and display the new recommendations (e.g., modify DMS message from "Accident Ahead" to "Congestion - Expect Delays").

(4.1.2.3) SELECT/ MODIFY COURSE OF ACTION

This process allows the user to accept, modify, or bypass the decision support recommendations for device usage, resource requests and notifications, and equipment. The system displays the full plan recommendations, and the user can make the desired changes.

To modify the course of action, the user can select/deselect resources and modify the messages for resource requests (new) or devices (same as current capability) as desired.

Note: Although cameras can and should be associated with an event to allow the images to be sent to other interested CHART video users in that area of responsibility, there still needs to be a way to use and control a camera without it being required to be associated with an event.

(4.1.2.3.1) SELECT/ DESELECT RESOURCE OR DEVICE

This process allows the user to select or deselect the resources, equipment, and devices (DMS, HAR, camera, monitor, etc.) that are to be used for the response.

(4.1.2.3.2) ENTER REFERENCE/ CHARGE NUMBERS

This process allows the user to enter the accident/incident report number (accident report or incident report; AR, IR) from the police, and the SHA charge number (e.g., typically for insurance cost recovery), if applicable. Note: These numbers are not required in order to execute the course of action, and may be entered at a later time. The actual charges (hours for CHART responders, property damages) are not tracked in CHART, but CHART could be the appropriate source for capturing and distributing the charge number(s). Note: Closed events are archived after 8 hours and are uneditable once they've been archived.

(4.1.2.3.3) SELECT OR ENTER APPROPRIATE MESSAGE

This process allows the user to select or enter the appropriate message for the resource or devices that broadcast messages (i.e., DMS and HAR).

For resources, this may be a text or text-to-voice request for specific assistance, provide a charge number, or may be notification only (e.g., for accidents in construction work zones, send notification to Chief Engineer/SHA, Public Affairs/SHA, District Engineer, etc.

For devices, the system should provide the user with a message template that is already formatted based on the device characteristics (e.g., 3-line DMS), and which could be pre-populated based on event type "Accident ahead", and as much specific data as is available (e.g., route number from the event location). When creating messages on the fly, the system should allow the user to skip words when using the spell-checking feature and allow the spell check to continue. Currently if the user clicks Cancel (the only way to skip), they cannot continue checking the rest of the message.

The user should also have the capability to listen to and edit a HAR message from the library when it's being used in a plan. Currently the "preview" button is only available while the user is creating it in the message library.

(4.1.2.3.4) ADJUST CAMERA PARAMETERS AND MONITOR ASSIGNMENT

This process allows the operator to modify the decision support plan recommendations for camera parameters (e.g., pan in the direction of the event, block or not block) and monitor assignments to specific centers.

Currently there is a static assignment of media feeds to Baltimore and DC media. This needs to be reviewed to determine if this meets long-term needs.

(4.1.2.4) EXECUTE COURSE OF ACTION

This process automatically executes the course of action once the user has selected the course of action. Examples: Response assistance is requested of the specified resources via the pre-determined method(s), messages are sent out to the specified DMSs and HARs, cameras are automatically re-aimed (override any dynamic tours), and monitors in the appropriate areas of responsibility are updated with the appropriate views (e.g., MSP barracks within area of responsibility will get the new camera view).

Note: Pre-determined methods include the mechanism to fax, e-mail, instant message, and/or page, using the appropriate interface.

In addition, the status for each resource participant or equipment would automatically be updated to "notified" (or similar status type; see requirement below), and the CHART map would automatically be updated with the devices, messages, lane closures, and alternate route/FITM plan. The process should also allow the user to update the statuses for each of the affected resources, devices or equipment so the operator would know all of the participants and equipment and the status for each. The current statuses need to be reviewed during design; (e.g., potentially add “in-route").

(4.2) RESPOND TO AND MONITOR EVENT

This process facilitates event response by providing ways to communicate information about the event between the CHART operators and on-scene responders. It includes the ability to monitor the status of the resources (dispatched, arrived), devices, and scene activities; and to manage traffic both at the scene (e.g., cones, arrow board) and in the affected area (e.g., signal management).

(4.2.1) MONITOR EVENT

This process allows field operations and CHART operators to monitor the status of devices, resources responding to an event, and the event response activities.

(4.2.1.1) MONITOR RESOURCE STATUS

This process allows the operator to monitor which resources are responding to an event. It includes getting feedback from automatically requested resources on whether they can respond and determining if (and which) additional resources may be required. This is particularly important for knowing field unit driver status. Decision support may be useful here. Example: If the maintenance shop reports that the requested equipment is not available, the system should provide the operator with the suggested next closest other facility based on "area of responsibility" that's predefined at x mile radius.

Additionally, this process allows the operator to update the status of each requested resource (e.g., "dispatched", "arrived", "departed") based on communication from the scene (either field operators, 911 updates from the fire board or other resource). Each status change would include the operator userid and date/timestamp.

The operator should also be able to request additional resources as conditions change.

(4.2.1.2) MONITOR ACTIVITIES

This process allows the operator to observe or get verbal or CHART-based messages on specific scene activities. This could include the use of CCTV, cameras on the trucks providing live feed or snaphots, and field operations reports of change in status of overturned vehicle, lane closure changes, etc.

The decision support feature should also prompt the operator to make changes to devices, resources, and the CHART display when certain activities occur. Example: Changes in lanes closed should prompt the operator to update the DMS message accordingly and the system should automatically update the map to textually and/or graphically display which lanes are closed.

In the future, new technology could be used to automate work zone monitoring to see when lanes open up, and to assess traffic flow in the area.

(4.2.1.3) MONITOR DEVICE STATUS

This process allows the operator to view the status of a device and to view it's data or message. This also includes automatically notifying the operator when a message did not go out (or view not available for cameras), or when the device is not online due to maintenance or repair (vs. a DC power error which may NOT mean the message is not being displayed. This requires new integration with the device status web page.

Currently the primary way of knowing whether a DMS or HAR is operational is by viewing the system, however, verbal feedback from field operators that the devices are appropriately displaying/broadcasting the event information is always desired.

For devices that were already displaying a message before this event was initiated, the system automatically arbitrates the message queue in accordance with the previously defined business rules with the ability to allow the operator to evaluate the message queue, arbitrate the message queue, override a queue, remove a message from the queue.

Note: Not all of the message protocols have been implemented, and there may need to be some adjustments to the arbitration business rules to address prioritizing messages based on geography and severity in addition to just event type (which is currently the only arbitration queue factor).

(4.2.2) CONTROL ON-SCENE TRAFFIC

This process is mostly done at the scene by field personnel in coordination with other agencies on the scene, and does not currently require direct CHART system interaction. However, operators must remain in constant contact with units on the scene of any incident, via Nextel or SHA radio, to keep abreast of changing situations. This process includes protecting the scene for traffic control, and facilitating the movement of traffic around the scene (e.g., arrow board, cones, flares).

In the future, additional technology should be considered to facilitate better communications between field personnel and CHART operators (e.g., on-scene arrival, lanes open/closed; use of instant messaging possibly via PDA), and to provide a capability to display SOPs/checklists/FITMs on a portable device.

(4.2.3) MANAGE AFFECTED AREA TRAFFIC

This process allows CHART operators to work closely with signal management and field operations to ensure that traffic flow in areas affected by the event is restored to normal as soon as possible. This includes calculating queue length on affected arterials in all directions including "rubber-necking" flow, and managing signal flows to increase throughput on clogged roads.

Currently this is managed by phone calls to the signal shop, a suggested enhancement is that the signal shop could be automatically notified as part of the executed course of action, and have access to CHART to record intended actions. Another suggested enhancement is the capability to manage signals (e.g., adjust timing remotely) through a CHART interface.

This process requires that the system collect speed data from detectors and probes, calculate queue length, and make recommendations (decision support) on signal timing adjustments, alternate route suggestions, etc.

Currently, as a non-automated part of managing traffic in the area affected by an event, spare responders monitor the roadways for secondary accidents and preventive measures.

(4.2.4) PERFORM SCENE ACTIVITIES

As with the control of on-scene traffic, this process is mostly done at the scene by field personnel in coordination with other agencies on the scene, and does not currently require direct CHART system interaction. This process primarily ensures that the road conditions are safe for the motoring public by repairing or minimizing damage to the surface, mitigating slippery conditions (e.g., applying sand for antifreeze, oil leak/spill), removing dangerous materials such as glass, debris, or animal carcass from the roadway, and leaving warnings or barriers for conditions that cannot immediately be rectified (e.g., set out barrels).

As with the control of on-scene traffic, this process requires close communication with the CHART operators so they can monitor the activities.

(4.3) CLOSE EVENT

This process allows the operator, in close consultation with field personnel, to determine that an event is closed (scene clear, responding resources departed, etc.); or to determine if the on-going event needs to be changed to a different event type and the resources transferred to the new event. Closing the event has the affect of notifying all affected parties that the event is closed (including those previously notified or asked to respond), automatically returning all devices to their default state (DMS, HARs, cameras, monitors), and updating the map with the latest lane status and devices status/messages.

This process also includes post-event analysis that will be supported by reports from CHART.

(4.3.1) VERIFY SCENE CLEAR

This process is mostly done at the scene by field personnel in coordination with other agencies on the scene, and does not currently require direct CHART system interaction. However, operators must remain in constant contact with units on the scene in order to receive the updated status that the scene is clear.

For field personnel, this process includes opening the lanes to normal traffic flow, departing the scene, and notifying operations that these two actions have happened.

(4.3.2) DETERMINE EVENT CLOSURE OR TRANSFER

This process allows the operator to determine if an event should be transferred to another event type (e.g., an accident is cleared so there are no more response activities, but congestion delays remain), or if the event is over and needs to be closed (e.g., Ravens game is over, residual delays from an incident are so minor that it's not necessary to open a congestion event). The system should prompt the operator to make this decision.

(4.3.3) CHANGE EVENT TYPE

This process has the affect of:

- Changing the original event status to closed (for statistical purposes).
- Opening a new event with a different event type.
- Transferring key data (e.g., resources at the scene, vehicle tag numbers) about the previous event to the new event.

It is most commonly used when the nature of an event has changed (e.g., accident is now congestion, a disabled vehicle has been hit and is now an accident), but may also be used when an event is initially incorrectly classified. Business rules need to be defined for which events can transfer to which other events.

The business rules for transferring events need to be determined to make sure the performance measure statistics are not adversely affected (e.g., no double-counting), to ensure that each event has its own separate event response history, and to make sure the transferred event does not override another event that may occur in this same area.

(4.3.4) RECORD EVENT CLOSURE

This process is done in response to one or more of the following conditions:

- Field personnel or contractors reporting that the event scene is clear.
- CHART operator receiving updated notification from detectors that the conditions are no longer event-worthy.
- Scheduler notifies the operator that the event is over.

When the operator determines or confirms that the event is closed, a series of actions takes place (not necessarily in the order implied below):

- All lanes closure statuses return to their default and the map is appropriately updated.
- All devices return to their default state and the map is appropriately updated.
- The status of all equipment is returned to 'available for service' (or other appropriate status to indicate that they are no longer responding to the event).
- All resources associated with the initial notifications (per the executed event response plan, and subsequent updates to responding or notified parties) are notified that the event is closed.

(4.3.5) CONDUCT POST-EVENT ANALYSIS

This process is primarily performed off line by CHART management and CHART operators. It is facilitated by CHART reports and may be more automated in the future to include automated comparisons of similar events (e.g., compare durations, types of equipment or personnel used in response, queue lengths), or events with similar geographic profiles (e.g., geolocation, road type).

It was suggested that some reports could be automatically generated and sent to supervisors, shift managers, etc. for analysis.

4.3.5 (5) MANAGE TRAFFIC

This process leverages traffic flow data and CHART resources to manage freeway and arterial traffic flows with the goal of greater efficiency and safety. Better traffic management also allows CHART to do better incident management. This process is primarily focused on non-event-related, recurring traffic conditions to prevent or relieve traffic congestion and balance traffic flow. It includes managing traffic flow through the intelligent use of signal control (based on both historical and current conditions), and providing traveler information on travel times and alternate routes. Being able to improve traffic management on logical, diversionary, alternate paths is one of the biggest problems to overcome. CHART may have an advantage because currently many signals are managed at the state level (vs. local level) which could assist with the management of traffic.

With respect to signal control, arterial signal systems are being installed statewide to provide remote and adaptive traffic signal control and coordinated signal timing. The extent of and schedule for this statewide installation is not fully known by CHART. Traffic signal technicians and CHART system operators can better balance demand and capacity by adjusting traffic signal timing remotely which requires either more visibility and access into the signal management systems, or integrating those capabilities into CHART. This also assumes that there is increased data collection and monitoring on arterials, either through additional CHART devices or resources, or through enhanced partnerships with agencies or private parties who have devices or resources already in place.

With respect to traveler information on alternate routes and travel times, this should not be limited to the amount of information that can be displayed on a DMS but can include more information that can be relayed on a HAR or web site. This is particularly important for recommendations for alternate routes.

This process includes the sub processes listed below and shown on the figure that follows:

- Control Signals and Roadway Access
- Recommend Alternate Routes
- Calculate Travel Times

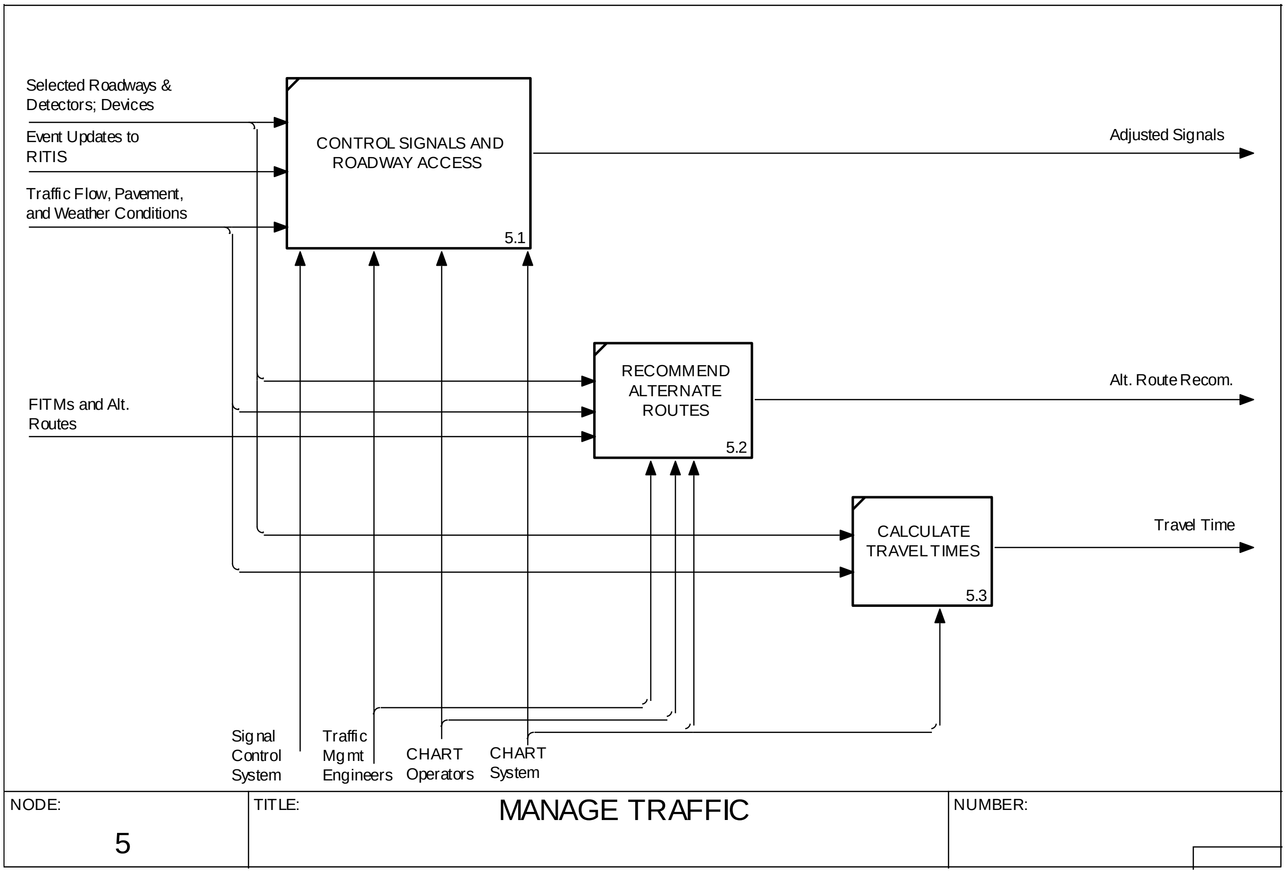


Figure 4.3.4-1 Sub Processes for Manage Traffic

(5.1) CONTROL SIGNALS AND ROADWAY ACCESS

This process currently requires that operators identify conditions that require signal adjustment through observation, field personnel reports, and other notifications (e.g., traveling public, media). These observations are then forwarded to the Signal Shop for action. Several of the workshop suggestions below assume significant upgrades to current signal control systems, integration of signal control at the physical level, and an interface to CHART. They do not necessarily imply that CHART has assumed responsibility of all statewide systems.

Suggested capabilities could include allowing the system to:

- Detect traffic conditions that could be managed by better signal control.
- Make recommendations on signal adjustments in order to facilitate traffic flow based on pre-planned signal timing plans.
- Allow the operator (in consultation with traffic management engineers) to accept, modify, or reject the signal adjustment recommendation.

The system could use traffic flow data to determine if traffic build up has reached pre-defined thresholds, and identifies the signals which are adversely affecting flow and those which could be used to alleviate traffic conditions. It also calculates and recommends the degree of adjustment (e.g., 30 seconds).

In the future this process may also include ramp metering and ramp control (more likely for entrance ramps to CHART-managed roadways).

(5.2) RECOMMEND ALTERNATE ROUTES

This process allows the system to compare historical traffic flow data against current conditions, and (if conditions warrant) recommend alternate route information to be posted on the web site, broadcast via HAR, and/or delivered to the public via some other means (e.g., future 511 capability). The user will have the option of accepting or rejecting the recommendation. This is similar to the decision support recommendations used for event management, but does not require that an event be opened.

(5.3) CALCULATE TRAVEL TIMES

This process allows the system to calculate the time that it takes to travel between pre-defined system points based on speed detectors; and possible future probe data from cell phones, vehicle infrastructure integration, and toll tag tracking. Theses travel times are automatically posted to the pre-defined traveler information system outlets (website map, DMS, HAR, etc.; refer to process 2.3.2).

4.3.6 (6) PROVIDE TRAVELER INFORMATION

This process provides pre-trip and en-route real-time information about traffic and roadway conditions by:

- Broadcasting information to the public via DMS and HAR.
- Providing camera feeds to approved agencies and partners, and to the public via the web.
- Posting information on the public CHART website.
- Providing CHART information directly to third parties (e.g., travel bureaus, the media) for dissemination to the public.
- Providing recorded information that is available via telephone (e.g., currently via Travelers Advisory Telephone and MdTA's Bay Span, and in the future via a 511 capability supported by RITIS).

This process includes the sub processes listed below and shown on the following figure:

- Broadcast Information
- Maintain [External] Web Site Information
- Provide Recorded Information
- Provide CHART Information to Third Parties for Public Dissemination
- Provide Camera Video Feeds

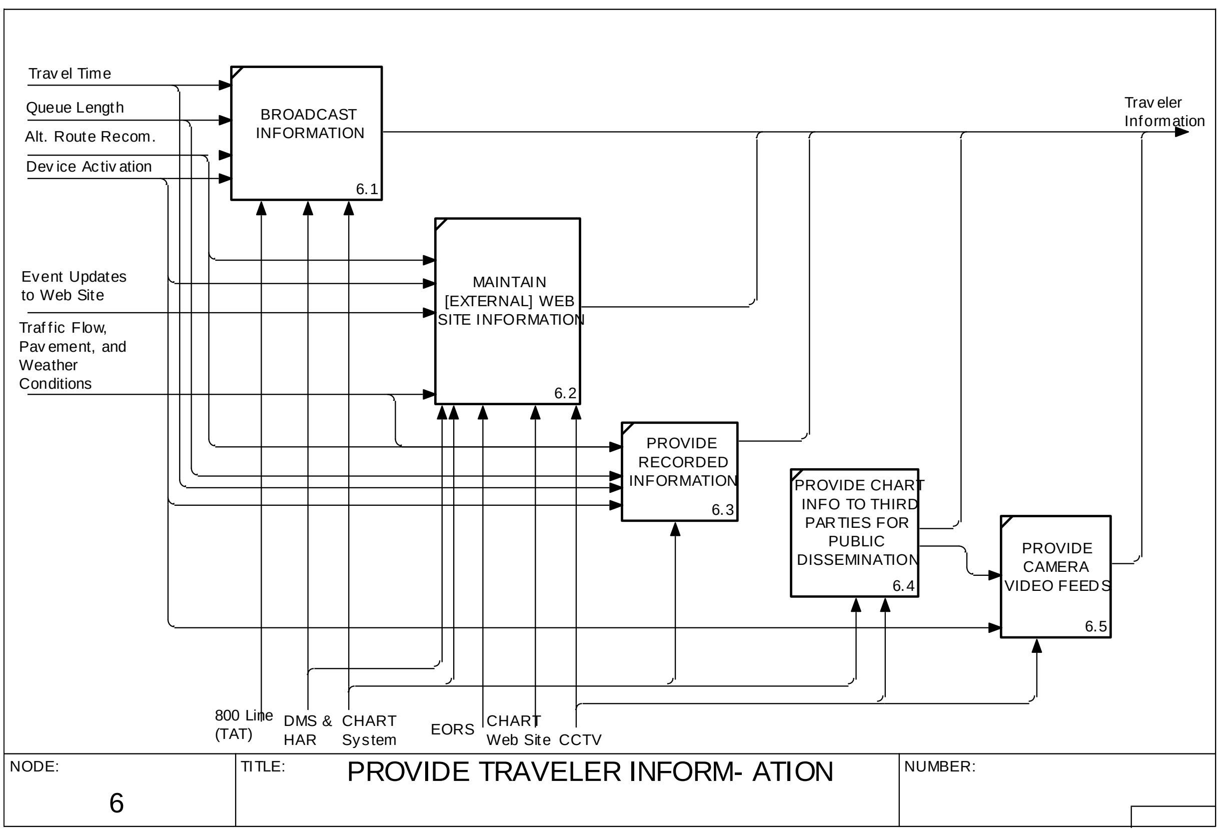


Figure 4.3.5-1 Sub Processes for Provide Traveler Information

This process can be triggered by response to an event that activates the device, or may be information that is passively displayed or broadcast (e.g., queue length, roadway conditions, travel time, camera video). Traveler information focuses on planned, predicted, or accidental traffic disruptions. It includes but is not limited to warnings of hazardous conditions or congestion, public safety information, alternate routes or detours, and travel time information.

(6.1) BROADCAST INFORMATION

This process provides audible and visual or textual display messages to several types of devices. The content of the message and the trigger to activate the device (where necessary) are initiated (or calculated and dynamically updated in the case of queue length and travel time) by an earlier process.

This information is currently provided to HARs and DMSs. However, in the future, this information could be provided to kiosks, traveler information boards, AM/FM side-band travel alerts, and motorist in-vehicle displays.

Note: Displaying travel times requires device activation. Currently the business rules are that a device is not activated outside of an event, but in the future this will not need to be true (at least for travel times, and possibly some other device activations) since they could be timed using a scheduler or set as a default to always display instead of a blank sign. This may obviate the need for "congestion" as an event type, but this will need to be confirmed during design.

(6.2) MAINTAIN [EXTERNAL] WEB SITE INFORMATION

This process facilitates the updates to the public-facing web site. The information on this site does not require CHART operator action, and is generally maintained in one of two ways:

- By automatic data feeds from devices, detectors, and event activation for CHART or CHART-related systems such as EORS and RWIS.
- By a CHART web master.

The web site not only includes data from the CHART system, but also has links to other regional traffic-related web sites, and links to documents.

Some specific updates to the web site presentation include:

- Moving the alerts from a flashing clickable option to a ticker running across the bottom of the page.
- Reorganizing information displayed on the map and adding new information such as travel times.
- Removing the requirement to use Real Player for video viewing.

(6.3) PROVIDE RECORDED INFORMATION

This process provides recorded information to the traveling public via telephone. This information is currently provided by Traveler Advisory Telephone services or MdTA's Bay Span. However, in the future, this information will be provided by a 511 system that will likely be supported by RITIS, and will accept recorded dynamically updated information related to CHART activities (and activities from other states' transportation departments, I-95 Corridor Coalition, etc.) for distribution via an integrated voice response system.

The content of the message is currently pre-recorded but in the new 511 system it will be dynamically updated based on the event activities (e.g., queue length and travel time) by an earlier process.

(6.4) PROVIDE CHART INFO TO THIRD PARTIES FOR PUBLIC DISSEMINATION

This process provides limited capabilities to third party CHART users. Based on the system administrator-defined privileges, these users can view (only) events and event status, can select cameras to view, and can assign camera views to monitors in their facility. Examples of these third parties include: media outlets (e.g., Clear Channel), and other agencies (e.g., MSP, VDOT, AADPWT, DCDOT, PGTRIP, AA911, Harford 911).

(6.5) PROVIDE CAMERA VIDEO FEEDS

This process facilitates the distribution of video feeds directly to the Baltimore and Washington television media. These are selected video feeds only (determined by the CHART system administrator), and do not include any views from snapshots cameras or views that CHART temporarily blocks from public view.

Note: Additional requirements have been documented for camera control and display, and for allowing appropriately authorized users to block camera views from the media or other specific outlets.

4.3.7 (7) MANAGE CHART PERFORMANCE

This process allows CHART managers and others to assess and enhance the effectiveness of CHART by reviewing and evaluating the performance of CHART operations, event management, traffic flow management, and devices and software performance. This process also includes simulation of event management and traffic management based on historical data. In the future, this process needs to include the identification of measures that promote the benefits of CHART (e.g., secondary incident avoidance, congestion relief by posting travel times).

This process includes the sub processes listed below and shown on the figure that follows:

- Manage CHART Operations Performance
- Measure Traffic Management
- Manage and Measure Device Performance
- Simulate CHART Operations and Traffic Management Performance
- Analyze Performance and Develop CHART Recommendations for Improvement

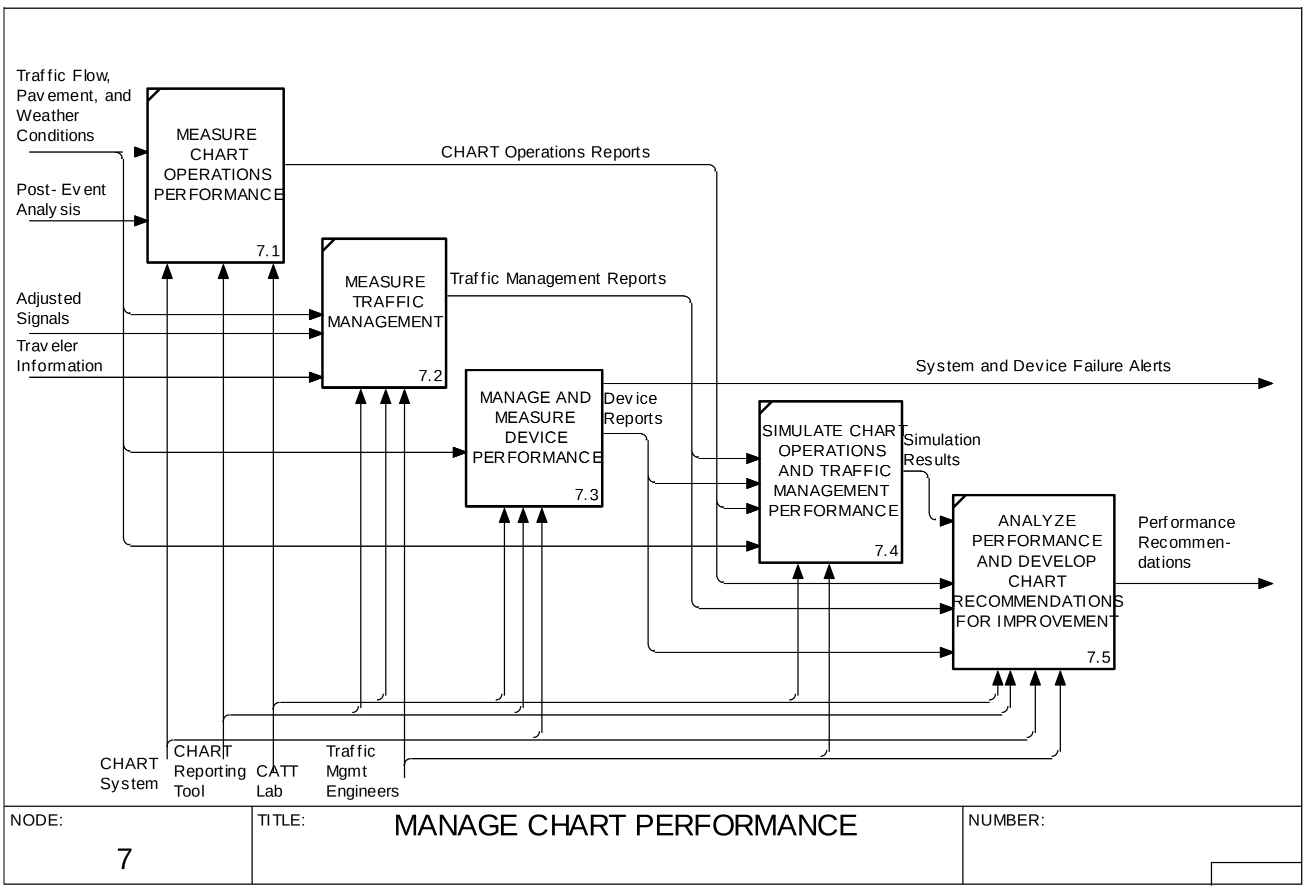


Figure 4.3.6-1 Sub Processes for Manage CHART Performance

A key issue for analyzing CHART performance is data validity. A suggestion was to validate the data maintained by CHART, to assist with the need to provide information on CHART performance. A possible way to assure data validity is to make specific fields mandatory, provide more error-checking, provide fewer text entry fields, and/or provide "smart" ways for the system to fill in data; e.g., automatically mapping an event to get correct latitude and longitude, adding date/timestamps for event activities vs having the operator record it, comparing probe-based speed data to speed sensor data to verify accuracy. This is also noted in the Data Model and Application Model sections of this BAA.

A recommended future activity is to determine what reports/analysis need to be generated real-time in CHART tools (e.g., status of CHART devices), slightly off-line or near real-time (e.g., number of incidents last week), and generated off-line for detailed trend analysis (e.g., average response time for incidents).

(7.1) MEASURE CHART OPERATIONS PERFORMANCE

This process allows CHART management to measure the effectiveness and efficiency of CHART operations by analyzing event data. CHART events form the basis for calculating operational performance measurements. From the event logs and other reports SHA/CHART management and other research entities (e.g., the University of Maryland CATT Lab) can calculate the number of events per specific roadway or operational center, etc. Data contained within these logs can be analyzed to determine the number of times and types of messages that were displayed on DMSs or broadcast on HARs, which signs or radios were used for how long, which cameras were used, etc.

Most of this process is done off line by CHART management and external industry analysts, but it is based on CHART data that is stored in an online operational database then moved to an archive database (refer to Section 7.2.2.3 for more information on data archiving). A mechanism is being implemented to provide a direct feed from the archive database to the University of Maryland CATT Lab. Reporting tools are used to extract and analyze this data.

This analysis is used to support achieving the results outlined in CHART Business Plan; and moving toward more proactive and preventative incident management -- where accidents are occurring, how weather and roadway conditions affect traffic, etc.

(7.2) MEASURE TRAFFIC MANAGEMENT

This process allows CHART management to measure the effectiveness of current traffic management practices. It includes the analysis of detector data, weather sensor data, and signal data (note: signal data is not currently integrated into CHART and detailed weather data is viewed from a stand alone system). This data is downloaded from the respective devices on a daily basis to the archive database. This data is maintained in raw data format. Traffic engineers having access to the archive database may analyze the data in the archive, or download the data to their respective analysis tools including the CHART reporting tool.

(7.3) MANAGE AND MEASURE DEVICE PERFORMANCE

This process includes monitoring and reporting CHART system (hardware and software) operation status, and device, detector, and sensor operation status. It includes the detection of anomalies such as equipment failures or out of service status for maintenance, response time to events, etc, and the detection of bad data from sensors and detectors (e.g., out of range, no data being sent). The process also includes the steps for troubleshooting devices, and generating statistical reports and analyzing performance. When the system cannot be repaired in the field, additional repair activities may need to be initiated (this is addressed in the Respond to Equipment Outage Process).

Currently, CHART does not get as much useful device data as they would like; especially on whether the device is working properly (e.g., the system says the sign is displayed but it's really not). They need more data, data that is more accurate (e.g., flag suspect data that says traffic is moving at 150 mph at 8:00 AM on 495), different types of data (e.g., direct speed data vs. a calculated average), and data on cameras. Specifically, CHART needs data on the frequency and length of camera usage (especially related to their use in event management), and on the frequency and types of out-of-service conditions. These data needs are also noted in Section 7.2.4.2.

The trends on device usage and performance should be used to establish service level agreements and prioritize maintenance activities (e.g., if a frequently used camera is broken, it should be repaired more quickly than an infrequently used on; if DMS is frequently breaking down, consider replacing it sooner than a device with less frequent break downs).

This process also includes requirements for self-checking (e.g., re-poll every 5 minutes) and self-healing where possible given current software and hardware constraints.

(7.3.1) CHECK AND VALIDATE SYSTEM AND STATUS

This process initiates the capture of data from polling for devices and hardware. It includes monitoring and pinging for system services, and checking for valid data from the device. Example: traffic moving at 60 mph but no vehicles present. Note: Automated polling of devices is not always sufficient. Currently if the user suspects that the device is not operating correctly, he/she needs to poll the device to make sure it is operational before calling the Networks Operations Center (NOC) and sometimes that solves the problem. .

(7.3.2) UPDATE DEVICE/ SYSTEM STATUS

The process facilitates the communication between the device and CHART and actually posts the status update to CHART.

(7.3.3) SYSTEM/DEVICE ATTEMPT CORRECTIVE ACTION

This process determines the device failure type and attempts self-correction (e.g., rebooting, failover). This process either fixes the failure or initiates a notification to the NOC that a failure condition has been detected and cannot be corrected by the device itself.

(7.3.4) NOTIFY NOC OF DEVICE/ SYSTEM STATUS

This process includes updating the status, confirming that the NOC has received the notification, and posting the confirmation back to CHART (so neither the device nor the operator reports the problem more than once). In the future, there needs to be more integration between the device status web page and CHART, and clear indications in CHART when a device is in a repair or maintenance mode (e.g., maybe change the color or provide some other clear indication). The future capabilities should also include automatic notification to others such as maintenance personnel, CHART systems integration team, and the device owner.

For devices that do not currently have an automatic polling and status reporting capability, or where the polling is not automatically detecting an error, there needs to be a way to report status via CHART directly to the NOC.

(7.3.5) INITIATE CORRECTIVE ACTION AND FOLLOW TO CLOSURE

This process is the troubleshooting of the device problem. It primarily occurs outside of CHART, but in the future, more updates on the device troubleshooting activities needs to be visible to the CHART user. Example: If the user knows that the device is not expected back in service for a week, he/she knows not to include that device in a scheduled event for the next day.

(7.3.6) GENERATE DEVICE REPORTS

This process includes initiating reports from the CHART reporting tool to assess device performance (e.g., mean time between failures, mean time to repair, number or corrective actions per device type).

(7.4) SIMULATE CHART OPERATIONS AND TRAFFIC MANAGEMENT PERFORMANCE

This process allows traffic management engineers to simulate event response scenarios and traffic flow conditions based on historical CHART operations data and predictive conditions. The historical data will be extracted from the CHART archive database which contains both operational event data and detector/sensor data, thereby providing highway conditions for traffic flow and identification of any actions taken by the CHART operations staff.

NOTE: The requirements for simulation outlined in the old BAA are provided below, and have been updated to include the provision for simulating the effectiveness of decision support plans prior to approving them for use as part of the "offline" capabilities described below.

This section of the BAA presents the conceptual approach to simulation to identify the uses of simulation and integration of the simulation tools into the overall CHART system. A summary of the support that simulation can provide includes:

- Assist CHART operators in a number of ways:
  - Improve with incident management and decision making skills
  - Represent lags in detector information to give a graphical representation of traffic flows
  - Estimate queue data on traffic congestion to tell how quickly a queue will clear
  - Allows for "what if" scenarios for handling situations differently
  - Predict signal timing changes on secondary roads during an incident or congestion situation
- Evaluate results of incident management and suggest improvements
- Gather metrics for future road planning
- Assist traffic planners with adjusting signal timing to improve traffic flows

The following diagram illustrates the conceptual relationships between the CHART operational system (highlighted in gray) and the simulation support tools. As illustrated, the simulation component utilizes real-time, archive and map data from the operational system to perform its functions, and outputs estimates, predictions, comparisons, and simulations in support of various aspects of traffic and roadway management for SHA and other MDOT agencies.

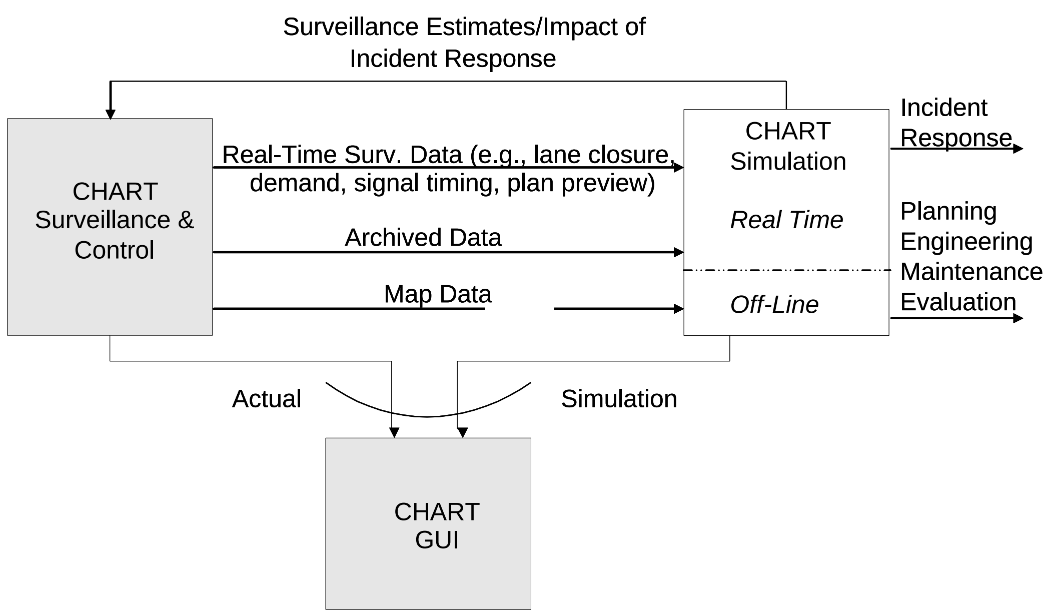


Figure 7.4-1 Conceptual CHART Simulation Schema

It was determined that simulation should be capable of providing three modes of support: Real-Time, Off-Line, and Training. These three modes are discussed in more detail in the following paragraphs.

Real-Time Mode

Real-Time mode is intended to provide simulation and decision support capabilities to support ongoing traffic management activities. As operators work a particular traffic management problem, they should be able to switch to the simulator in Real-Time mode and obtain evaluations of their current response plan as well as estimates of certain parameters that could affect the effectiveness of their response plan. By using inputs (e.g., real-time surveillance data, archived data, map data) from CHART, the simulator will give the CHART operators the ability to bring up the current response plan in the simulator. The simulator should be able to evaluate the effectiveness of the current response plan based on past experience calculated from the archive data. The simulator should also be able to predict traffic conditions as a result of the response plan, recommend changes to the response plan and project the resulting traffic conditions over time periods as the traffic situation continues or is affected by other projected conditions or the response plan.

The simulator needs to take into account other planned activities that might affect the response plan as the plan is implemented; such as planned special events and expected roadwork closures. The simulator should provide the operator with the reasoning behind its recommendations (e.g., identify that the congestion or queue will increase because a special event or recurring congestion is expected in the next 30 minutes, *or* it is the normal phenomenon of the current situation). Operators should also be able to tweak the current or suggested response plan (using the same CHART-type functions) to evaluate and build a better response plan, then be able to optionally modify and implement that enhanced plan when switching back into operational mode.

The use of the Real-Time simulation mode would usually be used for incident management and non-recurring congestion situations. It is expected that the simulation and decision support capabilities would assist the operators in these areas:

- DMS – when to post messages, where and when to change/clear messages
- Fill in surveillance (detector) gaps with estimates based on archived data analysis, redirection of traffic, and planned special events or roadwork
- Signal timing recommendations where appropriate
- Secondary roads – surveillance estimates and signal timing recommendations
- Estimate future traffic conditions – queues, travel times
- Assistance with estimating movement of backup queue due to congestion/incident

It is expected that the archive data will form the basis for the historical analysis and best practices capabilities of the simulator. It should be expected that the output results from the simulator would become more accurate over time as the archive data increases. Some balance/priority needs to be considered in defining CHART system releases in starting to collect Archive data as early in the release strategy as possible, but without delaying critical operational capabilities.

Off-Line Mode

The Off-Line simulation mode is expected to provide capabilities to analyze a specific past traffic situation and propose or evaluate the response plan that was used. It is also expected to provide the capability to evaluate proposed decision support event response plans or scheduled events to validate their expected results.
This mode will provide capabilities for evaluating how a past traffic situation was handled and then have the simulator suggest ways to improve the response. A past traffic situation should be able to be "replayed" and altered to see if the situation had been handled in a different way what the expected outcomes would have been. The simulator is expected to offer recommendations and critiques of the response activities based on analysis of the situation *as it happened*, and determine the effects of revisions to the response plan.

This mode should provide a means for an operator to input "what-if" scenarios to evaluate and adjust a proposed decision support event response plan or scheduled event before entering or modifying it into the operational system. The simulator is expected to play the scenario and highlight problem areas and make suggestions for improving the plan. Once a plan is simulated to the satisfaction of the operator, there should be a way for the operator to save that plan to the operational system.

Training Mode

Training is the third simulation mode. It is possible that an operator could be trained in managing specific traffic situations through the use of simulation. In this mode, the simulator is expected to present a set of specific traffic situations and then allow the operator to react to each of the situations. Several traffic situation scenarios can be established (with variables to prevent the same response plan from being anticipated) and played out for the trainee to devise and implement response plans. The simulator should be able to evaluate the response plans as the steps are executed and evaluate the results. It should also be possible to simulate changing conditions as the situation progresses and critique the performance of the trainee at the conclusion of the exercise. It is assumed that training scenarios and reactions to response plans would be based on best practices derived from information in the Archive database in order to provide training specifically tailored to the CHART environment.

(7.5) ANALYZE PERFORMANCE AND DEVELOP CHART RECOMMENDATIONS FOR IMPROVEMENT

All CHART personnel and SHA personnel are responsible for identifying, negotiating, and determining the cost/benefit of recommendations for improvement to CHART operations. Sources can include: the annual report, operator suggestions, planning group input, outside influences (FHWA, MDOT, and legislation), etc.

4.4 Business Process Performance Model

The activities performed in process 7.5, Analyze Performance and Develop CHART Recommendations for Improvement is a multi-level, on-going process. CHART management is vigilant in identifying and acting upon opportunities for improvement through changes in procedures, software applications, technology, etc. The benchmarks toward which CHART strives are outlined each year in the annual CHART Business Plan Objectives. For the most recent Business Plan (dated 8/10/06), the **goal is to ensure mobility and safety for the users of Maryland's Roadway network through the application of management and operations and interagency teamwork.** The specific objectives and the measurement of the success of meeting that objective are outlined below:

- **OBJECTIVE: ROADWAY MONITORING**
  Increase availability of key incident data in the Baltimore/Washington Metropolitan Area.
  Measurement: Percent increase of captured incident data

- **OBJECTIVE: INCIDENT MANAGEMENT**
  Provide effective incident management that reduces non-recurring delay (in vehicle hours) to achieve related cost savings for the traveling public, including commercial traffic.
  Measurement: Delay by vehicle hours / cost savings during non-recurring congestion

- **OBJECTIVE: TRAFFIC MANAGEMENT**
  Provide effective traffic management that reduces recurring delay (in vehicle hours) to achieve related cost savings for the traveling public, including commercial traffic.
  Measurement: Delay by vehicle hours / cost savings during recurring congestion

- **OBJECTIVE: TRAVELER INFORMATION**
  Achieve greater positive customer feedback regarding traveler information.
  Measurement: Feedback from website / media coordination meetings / postcards

- **OBJECTIVE: EMERGENCY OPERATIONS**
  Complete specified number of programmed Emergency Operations related enhancements, developments, and plans.
  Measurement: Percent of completed initiatives

- **OBJECTIVE: EMPLOYEE SATISFACTION**
  Increase employee satisfaction based on positive feedback on employee surveys.
  Measurement: Percentage of overall employee satisfaction

- **OBJECTIVE: BUSINESS PROCESSES**

Establish documented procedures to improve CHART's internal controls for procurement, inventory, and asset management.
Measurement: Creation of documented procedures for procurement, inventory, and asset management

Each year the results of CHART performance are evaluated by the University of Maryland's Department of Civil and Environmental Engineering which is contracted to provide analyze event data and make specific recommendations. The areas for evaluation include:

- Distribution of Incidents and Disabled Vehicles by Day and Time
- Distribution of Incidents and Disabled Vehicles by Road and Location
- Distribution of Incidents and Disabled Vehicles by Lane Blockage Type
- Distribution of Incidents and Disabled Vehicles by Blockage Duration
- Evaluation of Detection Efficiency and Effectiveness
- Analysis of Response Efficiency
- Reduction in Incident Duration
- Assistance to Drivers (e.g., gasoline, tire change)
- Potential Reduction in Secondary Incidents
- Direct Benefits to Highway Users (e.g., reduction in delays, fuel consumption, emissions)

The annual report provides detailed statistical analysis and recommendations for improvement.

4.5 Business Process Recommendations

To continue to improve CHART's performance and fulfillment of its goals and objectives, several specific suggestions were documented during the workshop analysis of the processes described in the previous sections. Many of these suggestions were categorized as mid-level requirements (not so high level as to be too generic, but not so specific as to constitute system requirements). Other specific suggestions were left as standalone requirements for CHART enhancement that will be addressed through the change management process (e.g., create pop-up and audible alert for CHART Chat).

Approximately 50 mid-level requirements related to *business process changes* were identified. Each of these was evaluated as part of the Release Strategy activities that are more fully described in Section 10.

5 Organization Model

The Organization Model describes the organization as a whole and is presented here in three major areas. This includes:

- The vision and principles, constraints, and assumptions that influence the CHART organization.
- CHART's organizational context which includes an assessment of its key stakeholders, a depiction of the organizational structure, and a description of the roles recommended for the organization to operate.
- CHART's recommended organizational changes and specific strategies to enable the organization to achieve its objectives.

Each of these major areas is presented in the subsections that follow.

5.1 Organization Direction

In the next phase of the CHART System, CHART will move further toward reaching its goal of better serving the traveling public by evolving as an organization of traffic managers. The vision and key principles, constraints, and assumptions that will guide this evolution are described in the subsections below.

5.1.1 Organization Vision

The key statement for the vision for CHART locations, as described by the workshop participants, is:

Better support CHART execution through alliances and system-supported job enhancement.

Specific examples of this are outlined below:

- CHART will provide decision support tools that will allow operators to become traffic managers not data entry clerks.
- The cooperation between CHART and its key stakeholders will increase to the point at which:
    - CHART partners actively and fully support our agreements on procedures, protocols, and data sharing.
    - CHART systems will be fully integrated with other agencies such as VDOT, DDOT, DC, PENNDOT.

5.1.2 Organization Principles

CHART personnel work together very closely and exhibit a great deal of camaraderie. As a result, CHART's organizational principles reflect fairness and an attempt to empower its employees and other CHART users with the ability to manage traffic and respond to incidents on the roads. This is reflected in CHART's principles below:

- CHART will coordinate and assist in training responders who are developing their own new local traffic management programs (e.g., county).
- SHA and MdTA will agree and implement CHART policies (e.g., consistent signs and messages).
- Device owners will always be able to control their devices (e.g., not ever be locked out).
- Authorized CHART users will be able to initiate an event.
- Everyone with appropriate CHART access can see event data and add to the status of the event.
- Designated system administrators can make adjustments to user access and permissions as necessary, and configure zones of responsibility.
- HOT Team Leaders coordinate responses and arbitrates any conflicts.

5.1.3 Organization Constraints

While the CHART organization is ambitious and committed to its work, certain factors limit the organization's capacity to evolve. As a result, CHART attempts to prioritize its efforts and operate more efficiently to offset its constraints. CHART's primary constraints are:

- Positions and vehicles (resources) are limited.
- Because of the demand of the positions, CHART has difficulty attracting personnel with appropriate skills.
- CHART has the administrative burden of other SHA offices but doesn't have the support staff.

5.1.4 Organization Assumptions

CHART's success depends in part on certain factors over which it exercises little control. In an attempt to plan for CHART's future development including the supporting infrastructure, software and technology, CHART has made certain assumptions that include:

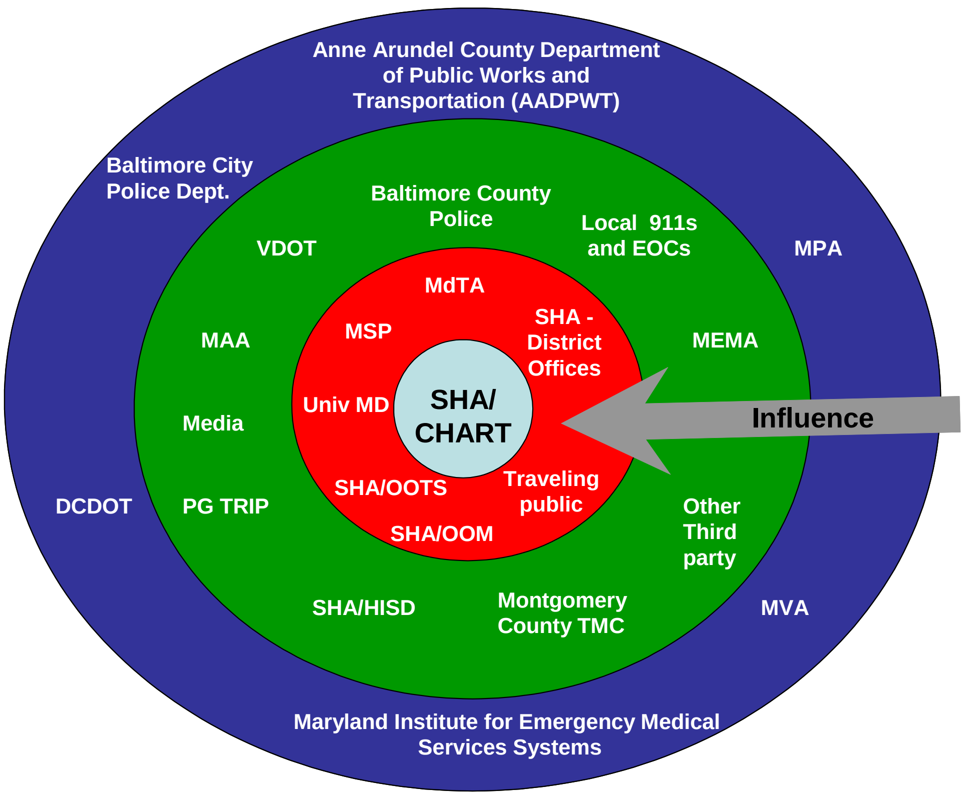
- Both CHART and non-CHART personnel will receive training on how to use the CHART system.
- CHART assumes, but cannot reasonably expect the highest level of cooperation from its partner agencies.
- The CHART organization will work with private/public partnerships that affect many areas of the organization.

5.2 Organization Characteristics

This section describes CHART's organizational characteristics. The subsections reflect an "outside in" approach beginning with external stakeholders, CHART's context within SHA, then the internal CHART organization. This section also describes the existing culture and the key competencies needed for CHART to operate effectively.

5.2.1 CHART Stakeholders

The key stakeholders and their relative level of influence on CHART's mission are shown in the figure below. SHA CHART is shown in the center and it is most heavily influenced by the organizations in the center ring. The degree of influence decreases the farther the organizations are away from the center. For example, the Maryland State Police (MSP), which is shown in the innermost ring, has a very strong influence on CHART as they respond to incidents and are responsible for notifying CHART operators when they are on the scene. By contrast, the MVA shown in the outer ring has little influence over the work done by CHART.



(Note: There are other local 911 Centers and EOCs that would fall into the middle ring that are not shown)

Figure 5.2.1-1 – CHART Stakeholders Relative Degree of Influence

This concentric circle diagram was created not only to depict CHART's relationship with its stakeholders but also to begin prioritizing outreach programs, soliciting requirements and strengthening partnerships by focusing on those stakeholders closest to the center. The suggested steps to achieve this are outlined in the Organization Recommendations, Section (5.3).

The table below provides more descriptive information on the role of the stakeholders noted on the graphic above and the ways in which they use or interact with CHART. The stakeholders are listed by groupings in the order in which they are depicted in the graphic (inner ring to outer ring).

Figure 5.2.1-2 – CHART Stakeholder and Role Definitions

Stakeholder	Role Definition
Maryland Transportation Authority (MdTA)	The Authority is a self-funded, agency in MDOT that is responsible for managing, operating, and improving the State's toll facilities.
Maryland State Police (MSP)	Responsible for law enforcement, accident reports, car seat inspections, firearm registration, sex offender registration and vehicle inspections. A number of MSP barracks have access to CHART video, applications, and device data.
University of Maryland (UMD)	The largest public institute of higher learning in the state. Hosts the Center for Advanced Traffic Technology (CATT) laboratory at the College Park Campus. Access is provided to CHART video, applications, and data. The center provides statistical analysis and reporting of historical CHART data. It is also a primary development center for regional ITS initiatives that are potential future CHART interfaces; e.g., Regional Integrated Traveler Information System (RITIS).
SHA Office of Traffic and Safety (OOTS)	OOTS provides a wide range of traffic engineering, traffic operations, and traffic safety support to SHA's Districts and other units that enable them to carry out their highway responsibilities. It also houses SHA's motor carrier division and serves as the lead agency for Maryland's traffic safety programs.
SHA Office of Maintenance (OOM)	Responsible for the maintenance of SHA controlled roadways and related infrastructure. Are responsible for the physical maintenance and repair of the CHART field devices: CCTV, DMS, RTMS, HAR, SHAZAM, RWIS.
Traveling Public	The users of transportation infrastructure and services in the State of Maryland: motorists, mass transit riders, air and rail passengers, shippers, etc.
SHA District Offices	SHA has divided the state into seven geographic districts for the distribution of personnel and resources required for road maintenance, clearing operations, and fleet maintenance. Each district consists of a main administrative office (the District Office) and several regional maintenance shops. Personnel, equipment, and supplies are distributed across the shops to facilitate quick dispatch/response to any area in the district.
Maryland Aviation Administration (MAA)	Responsible for the operation and maintenance of public aviation facilities in the state and associated perimeter ITS devices. MAA DMSs are integrated into CHART.
Media	Public communications providers such as television, radio stations, and web service providers. Access to CHART video is provided to television stations in Baltimore and metro Washington; and access to CHART video and data is provided to private traffic information providers.
Virginia Department of Transportation (VDOT)	Responsible for managing, operating, and improving the State of Virginia's transportation assets: highways, roads, mass transit, etc. VDOT has access to CHART video, applications, and device data. VDOT/CHART data exchange and video sharing may be facilitated by the completion of the Woodrow Wilson Bridge project.
PG TRIP	The Prince Georges County Traffic Response and Information Partnership (TRIP) Center is the cornerstone for the county's growing traffic management and signaling systems. County-owned cameras are integrated into the CHART network and controlled using the CHART operational software.

Stakeholder	Role Definition
SHA Office of Planning and Preliminary Engineering, Highway Information Services Division (HISD)	HISD maintains the database of highway information in both electronic and graphic form; and is responsible for the development and support of SHA's Geographic Information System. HISD also produces Maryland's Highway Tourist maps, as well as many other map products which are available to other state agencies and the general public. The CHART Mapping Application uses HISD map products.
Montgomery County Traffic Management Center (MCTMC)	Montgomery County has its own extensive ITS infrastructure. The hub of operations is the MCTMC where access to CHART video, applications and device data is provided. CHART receives access to County-owned camera images in return.
Maryland Emergency Management Agency (MEMA)	Coordinates the state response in any major emergency or disaster including supporting local and Federal government. MEMA also operates a 24-hour Joint Command Center that utilizes CHART video and data. CHART video and data are also available to MDOT and MSP representatives who respond to MEMA during events.
Local 911 Centers and Emergency Operations Centers (EOC)	911 centers are responsible for initiating and coordinating emergency medical, fire, and police response services in their respective counties. EOCs are responsible for coordinating the counties' response to major emergencies or disasters. Current CHART partner sites receiving access to CHART video, applications, and data include: Anne Arundel County 911 Center, Baltimore County EOC, Frederick County EOC, Harford County 911 Center, Howard County 911 Center, and Talbot County 911 Center. Harford County also owns 10 cameras that are integrated into CHART and are controlled using the CHART operational software.
Baltimore County Police Department	Responsible for law enforcement in Baltimore County. The Headquarters facility is a CHART partner site receiving access to CHART video, applications, and data.
Anne Arundel County Department of Public Works and Transportation (AADPWT)	Responsible for maintaining County roadways and infrastructure. AADPWT is a CHART partner site receiving access to CHART video, applications, and data. Additionally, the county is deploying cameras that are integrated into the CHART network and are controlled using the CHART operational software.
Maryland Institute for Emergency Medical Services Systems (MIEMSS)	Responsible for coordinating severe emergency response services. MIEMSS is a CHART partner site receiving access to CHART video, applications, and data.
Other Third Parties	Private CHART sites (such as the TOCs at FedEx Field and M&T Bank Stadium that are only active on days an event is scheduled) and other agencies (local and regional) that SHA communicates/coordinates with (such as the I-95 Coalition) but not through CHART.
Baltimore City Police Dept.	Responsible for law enforcement in the City of Baltimore. The Headquarters facility is a CHART partner site receiving access to CHART video, applications, and data.
District of Columbia Department of Transportation (DCDOT)	Responsible for managing, operating, maintaining, and improving the District of Columbia's transportation assets: highways, roads, mass transit, etc.
Maryland Port Administration	Responsible for managing, operating, and improving the Port of Baltimore and its related infrastructure.

Stakeholder	Role Definition
Motor Vehicle Administration (MVA)	Responsible for private driver licensing; vehicle registration and titling; driving record maintenance; and commercial operator licensing, motor carrier permits, and regulatory compliance.

5.2.2 CHART Context in SHA

CHART represents Maryland's statewide Intelligent Transportation Systems (ITS) and Operations Program. CHART is a joint effort between the Maryland Department of Transportation (MDOT) and the Maryland State Highway Administration (SHA) in partnership with the Maryland Transportation Authority (MdTA) and the Maryland State Police (MSP) representing the highway operations element of the program. As shown in the figure below, within SHA, the Office of CHART and ITS development falls under the Deputy Administrator and Chief Engineer for Operations.

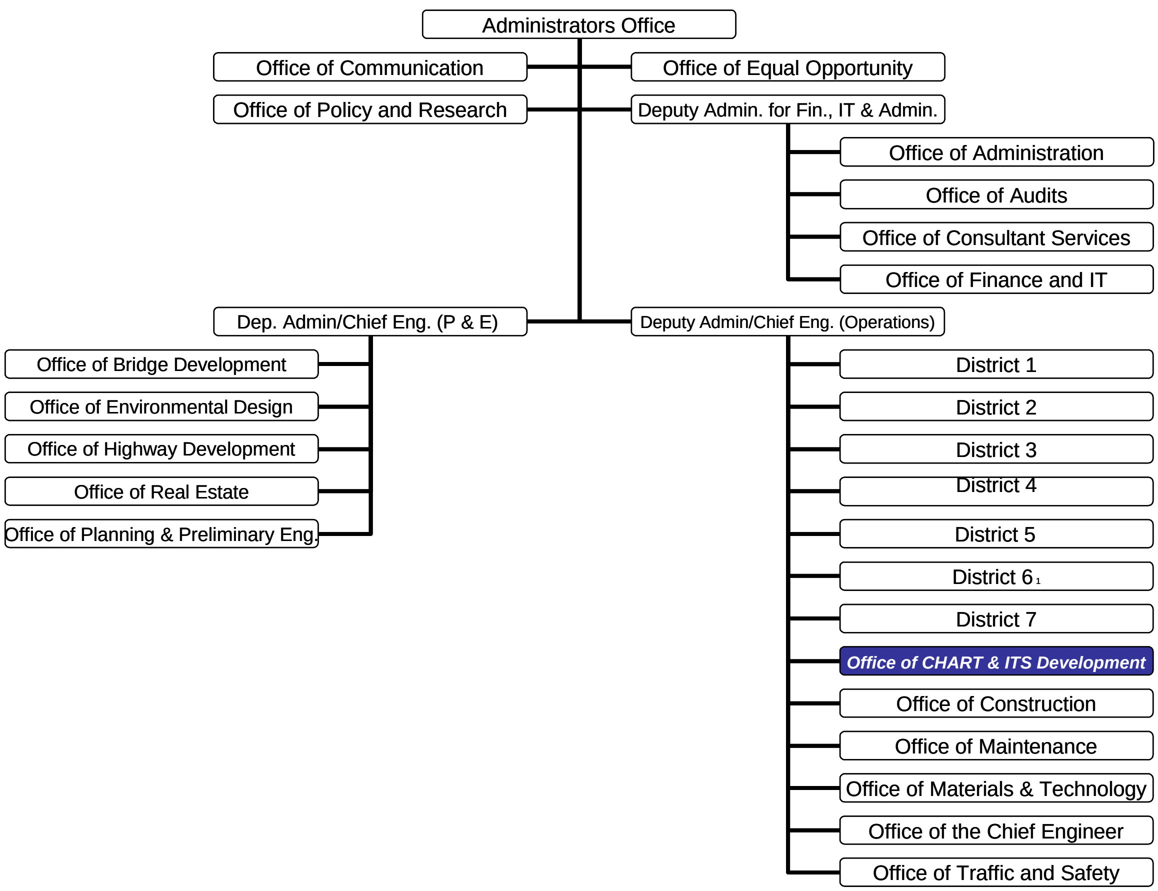


Figure 5.2.2-1 SHA Organizational Structure Showing Office of CHART and ITS Development

5.2.3 CHART Organization Structure

The CHART organization is directed by the CHART board which consists of senior technical and operational personnel from SHA, Maryland Transportation Authority (MdTA), Maryland State Police (MSP), Federal Highway Administration, the University of Maryland Center for Advanced Transportation Technology (UMD CATT Lab), and various local government. The board is chaired by the Chief Engineer of the SHA whose primary areas of responsibility are:

- Strategy and planning
- Manage budget and funding
- Define business objectives

The CHART organization is divided into four divisions (or teams): Operations, Integration, Development (Planning), and Administrative as shown in the figure below. Each team's responsibilities are briefly described in the table below the figure.

Figure 5.2.3-1 – CHART Organization Structure

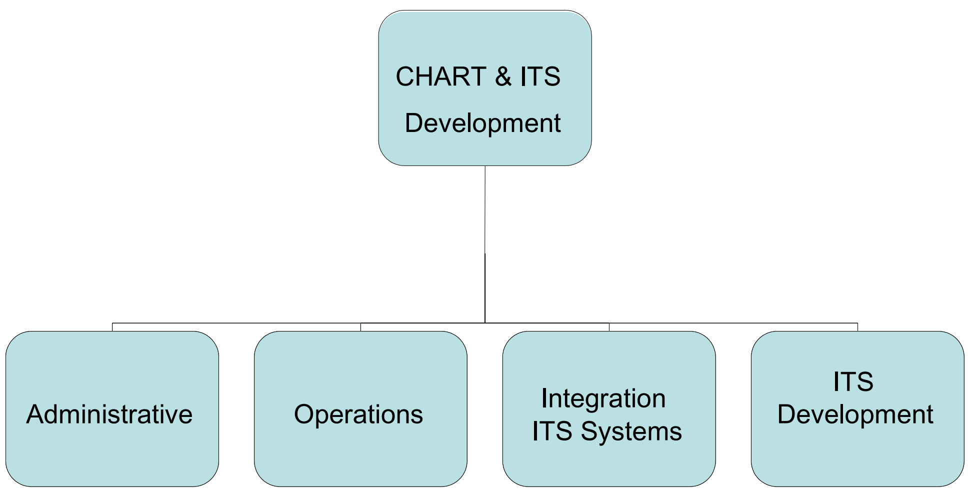


Figure 5.2.3-2 – CHART Teams' Responsibilities

Team	Responsibility

Operations Team	• Traffic management of state highways and arterials • Manage ETP, ERU and HOT operations • Monitor, measure, and manage operational accomplishments • Plan, prepare, and conduct ER training
Integration Team	• ITS Systems planning and strategy • Maintain infrastructure equipment and configuration • CHART application administration and configuration • Network administration and maintenance • Legacy systems administration • Applications change control and configuration management • CHART application maintenance • Database administration • CHART functional and user training
ITS Development Team	• Investigate new technologies • Develop ITS strategy • Define ITS objectives • Manage ITS development and deployment
Administrative Team	• Provides administrative support to other teams.

Within the Operations division, the Statewide Operations Center (SOC) is the primary operating center that oversees the operations of the regional Traffic Operations Centers (TOC)s. The SOC is the only center that operates 24 hours per day and 7 days per week. (Note: Similar activities take place at all TOCs, the primary difference is the geographical area of responsibility. See Location Model Section for details.) At all operations centers, personnel monitor SHA radio channels, Maryland State Police channels, and other sources of information, detect incidents and respond by dispatching emergency response personnel and shop personnel to the incident scene to reduce traffic congestion. The Authority Operations Center (AOC) is responsible for managing traffic and incidents on the MD Transportation Authority (MdTA) bridges, tunnels and roadways.

5.2.4 CHART Culture and Roles

CHART's culture is very collegial; personnel are very supportive of one another and enthusiastic about their work. CHART personnel are very committed to their jobs and to helping both motorist and other agencies involved in the betterment of traffic management. Some of the key roles within CHART are described more fully below.

Figure 5.2.4-1 – CHART Titles and Roles/Responsibilities

Title	Role/ Responsibilities

Title	Role/ Responsibilities
Highway Operations Technician (HOT)	• These are the operators who staff the SOC and the TOCs. There are four HOT levels encompassing entry-level to senior supervisor. Advancement is based on hands-on testing, interviews, and management training. Initial supervised training at SOC then assignment to various regional TOCs. • Responsible for using CHART and entering and responding to events.
Emergency Response Technician (ERT)	• ERTS are the personnel who perform the Emergency Traffic Patrol (aka, CHART Courtesy Patrol). They act as CHART's "eyes and ears" in the field. • During operational hours, four Emergency Traffic Patrols travel along State highways to report incident details to operators from the scene, assist police on-scene (with incidents and disabled vehicles) and aid stranded motorists. ERTs also report any incidents, traffic abnormalities, and malfunctioning field devices they may observe while on patrol.
CHART System Administrator	• Configuration of CHART System and managing CHART users.
Radio and Maintenance Personnel	• Maintain CHART devices
Traffic Management Analysts	• Use CHART data to analyze traffic paths and event management. (UMD CATT Lab)
Emergency Operations Support and Law Enforcement	• View CHART event data and cameras to monitor event activities and status.
Traffic Data Distributor	• Collect and distribute CHART data and camera images to public and private outlets (such as regional traffic management organizations via RITIS, Baltimore/Washington media,, etc.)

Some of the rules of engagement which govern the ways in which these roles interact are outlined in the CHART SOPs and listed below:

- Operational decisions at the SOC override decisions at any of the TOCs regardless of the level of the HOT at the TOC site.
- In general, the highest ranking HOT has the authority to override the others on duty, except in the above circumstance.
- The AOC can override anyone at a TOC or the SOC when it comes to the MdTA resources. (However, they will extend a courtesy call if someone at another center has control.)
- The Center is responsible for handling incidents; it is not necessarily the responsibility of the person who opened the incident alone.
- One of the primary responsibilities of supervisors (HOT IV) is to advise and support the more junior HOTs.
- If a HOT is outranked he or she should defer to the higher ranking HOT on all decisions. If they do not agree, they should discuss it with their direct supervisor later.

5.3 Organization Recommendations

There are three key areas for recommended organizational change:

- Improved stakeholder and interagency cooperation and coordination
- Improved employee retention
- Improved training

5.3.1 Stakeholder and Interagency Cooperation and Coordination

One of the essential assumptions for the CHART vision was "CHART assumes, but cannot reasonably expect the highest level of cooperation from its partner agencies." Several specific issues and suggestions were raised during the workshops relating to increasing the level of cooperation. One of these issues was the limited time and resources to work more closely with stakeholders on:

- Technology procurement and integration planning issues (e.g., cameras, devices)
- Data sharing issues (e.g., CAD 911 data, camera images)
- Regional emergency and expert response coordination issues (e.g., protocol for police working an incident, role of private tow company).

To mitigate the resource constraints for improving stakeholder coordination and improve the focus and quality of the communication with these stakeholders, CHART should consider identifying dedicated "ambassadors" to interface with each of its constituents beginning with those closest to the center of the "influence" picture (refer to Figure 5.2.1-1 above). This would compliment previously successful outreach activities (e.g., to MSP).

To further support improved stakeholder and inter-agency cooperation, a strawman communication plan that focuses on specific issues to be addressed with some key stakeholders is provided in the table below. This plan uses a "What I have to offer" and "What I need" approach to facilitate cooperation.

Figure 5.3.1-1 CHART Stakeholder Communication Plan Emphasizing What CHART Offers and What CHART Needs

Stakeholder	CHART Offers	CHART Needs
Traveling public	• CHART web site (need to advertise this more) • DMS/HARS for traffic information (promote use of messages focused on traffic vs. ozone alerts to increase public use and trust) • CHART Emergency Traffic Patrol	• Feedback on website • Feedback on effectiveness of DMS/HAR; need to respond to the feedback
MdTA System Users (AOC)	• Awareness and/or training on new features in CHART for users prior to/when new release comes out.. • Overview training for new employees. • Policy and procedure ideas	• Requirements for features and functionality in CHART • Specs, reqmts for new equipment that will need to be interoperable with CHART • Policy and procedure ideas
MdTA – IT and Engineering	• Awareness training on what CHART is and what it is not. • Provide requirements for	Groups within MdTA to take ownership of and participate in CHART development.

Stakeholder	CHART Offers	CHART Needs
	interoperability.	
Univ Md, CATT Lab	Direction for CHART (3-5 year) and requirements for RITIS (and other research efforts) to support the direction.	• Standards, data format prescription, etc. for RITIS • Plan for implementation and full support for moving research to operations. • Integration of what CHART needs to do and what RITIS is planning to do. • Performance Reports
MCTMC	Provide requirements for interoperability	Consolidated requirements for functionality and features from operators
SHA/HISD	Requirements for sharing data	Requirements for sharing of data (RTMS, GIS data layers)
SHA/OOM	Requirements for maintenance status and equipment reporting	Feedback on performance/repair issues with devices
SHA/OOTS	• Requirements for new sites • Requirements for new devices • Signals • Testing between OOTS and OOM	• Feasibility analysis and design status for new sites • Product analysis and procurement status for new devices
Media	Notification of new cameras coming on line.	Notify CHART of major events when they occur.
MSP	Awareness and/or training for CHART users on new features in CHART prior to/when new releases come out.	• Training that includes emphasis on need to communicate what info they need to provide to CHART during incidents (training that what we really need is lane closure info). • Status of CAD 911 system; interface requirements

Within this area of increased stakeholder and interagency cooperation, several other issues and areas for improvement were identified in the workshops.

Clarify Center Responsibilities. A greater emphasis should be placed on operator awareness of events that are managed by other operations centers. As an example, CHART personnel have reported that they are unclear whether the AOC or a TOC is responsible for managing traffic or updating a DMS related to managing an event such as the Bay Bridge walk. [Changes to the user interface design for the Operations Center home page might facilitate this). As a related issue, CHART needs clear protocols for managing shared events, people and software and for camera control by level of authority.

Provide Recognition for Drivers. As a matter of record-keeping and performance measures, CHART needs to find better ways to recognize the CHART drivers' role in responding to incidents. Currently they only receive direct credit for providing driver assistance such as disable vehicles or out of gas but they should get credit for the events that they identify and to which they respond.

Cooperation/Coordination with the Signal Shop. Currently coordination of event-related activities is hampered by several factors. This sometimes means a less than optimal response to events (especially incident clearing and congestion-related events). Example: CHART currently calls the signal shop to let them know that the signal shop may need to adjust the signals on an alternate route, but CHART does not know if or how they do it, nor is there any follow-up on either side to see if the signal timing adjustments (if any were made) are helping or hurting the situation.

5.3.2 Employee Retention

Another major organizational issue for CHART is its difficulty in retaining qualified employees. In some years, the CHART organization experiences a 40-50% turnover rate. The left column of the table below lists some of the symptoms or indications of retention issues. The right column shows some possible strategies to resolve the issues.

Figure 5.3.2-1 - Employee Retention Issues and Possible Strategies

Retention Issues/ Symptoms	Possible Strategies
New employees come in with expectations that this is a police dispatch, get disappointed when it is not as exciting, then quit.	• Include observation time in the SOC as part of the hiring/evaluation process.
Work ethic	• Review past experience more thoroughly before hiring. Ask for references.
Some new hires just don't get it.	• More careful interviewing/screening • Targeted, multi-level training • Mentoring for new operators
Lack of skills – especially PC skills	• Make computer skills a pre-requisite
Poor or non-existent entry-level testing	• Design and implement testing that really helps determine the likelihood that a candidate will do well in the job. Example: role playing - "What would you do in the following situation?"
Poor interviewing/assessing.	• Round table interviews (e.g., one candidate, many interviewers) • More explicit interviewing questions (see "what would you do" question above)
24 x 7 too hard	• Consider different types of shifts; (e.g., 12x7 or 24 x 4) • Increase/decrease shift rotations.

Two other staffing issues were raised in the workshops:

- **Number of operators on shift**. Sometimes the two SOC operators are challenged in handling multiple events in multiple regions; especially after hours when other TOCs are closed.
- **CHART staffing in District 6.** Currently this function is staffed by District employees, and direction is not always consistent.

5.3.3 Training Requirements

There are several types of training to consider that can be used to enhance the skills and knowledge of people that work both directly and indirectly with CHART. These types of training include:

- **CHART functional training** – a conceptual overview of the CHART program, terminology, SOPs, roles, and basic CHART application functions.
- **Application training** – multi-level, modular training in basic and advanced CHART application functionality.
- **Technical training for Professional Development** – skills training in equipment and applications that are used by CHART.
- **Periodic Ad-hoc special topic training –** scenario-based situational training in a CHART training environment.

Each of these training types is described more fully in the subsections below.

5.3.3.1 Functional Training

The recommended training should provide the users with a conceptual view of the processes supported by the CHART applications. Training should introduce the users to CHART terminology, traffic monitoring, event management and appropriate procedures and responses (e.g., SOPs, CHART application functions). This training should be directed to SOC, TOC, and AOC operators; Maryland State Police, and SHA maintenance personnel.

5.3.3.2 Application Training

The recommended training should provide CHART users with application-level training. Application training may be provided in modules and tailored to different levels of experience. Some suggested example modules are shown below:

- **CHART Event Management** – content would include:
    - **Basic Event Management -** opening an event, identifying location, monitoring activities and updating communications logs, etc.
    - **Advanced General Event Management -** content would include assigning resources, selecting and activating DMS/HAR, responding to potential events, etc. May also include training on related systems such as EORS SCANWeb, paging systems, etc.
    - **Advanced Special Event Management** – subjects would include weather emergencies, multi-responder incident management, monitoring for potential events, etc. May include training on related systems such as WebEOC, EMMA, etc.

- **CHART System Administration and Device Definition** – subjects would include an overview of the system parameters and values of each parameter, and configuration data. Includes defining user types, adding/deleting permissions for roles, adding/deleting devices.

- **CHART Reporting Training** – subjects would include an overview of the data being retained in the Archive Database and its logical structure and relationships; and use of the reporting features to obtain performance measurement and statistical data. This training should be directed to CHART managers and supervisors, and other non-CHART agencies who have expressed a need for access to the archived data.

5.3.3.3 Technical Training for Professional Development

Several types of technical training are offered to expand the skills of CHART users. This includes, but is not limited to training general computer operation (e.g., basic Windows navigation and PC skills); and traffic management specialty classes (e.g., Traffic Engineering Short Course, Traffic Signal Timing Principals, etc).

It was also suggested in the workshops that ancillary technical training in specialized areas might be desired for system administrators or other technical managers (e.g., equipment operation, operating systems, relational database structures, network components, IP multicasts, and multi-layer switching).

5.3.3.4 Periodic Ad Hoc Special Topic Training

This training would provide regularly scheduled (e.g., monthly or quarterly) informal awareness briefings on special topics of interest. The training format could be real time (e.g., brown bag lunch) or virtual (e.g., update on the "wiki" or file showing navigation tricks using a recorded demonstration.) Topics could include:

- Search tips (e.g., "Did you know you could search on 'bay' and get all the cameras, devices and events related to the Bay Bridge?").
- Upcoming CHART release features.
- New policy changes (e.g., a change in authorization required for declaration of a utility emergency).

5.3.4 Organization Recommendations Summary

To summarize, the key recommendations for organizational change are:

- Identify dedicated CHART "ambassadors" to interface with key stakeholders on a regular basis
- Develop clear protocols for managing shared events and communicate them to operators and field responders for SOC, TOCs, and AOC.
- Develop improved working relationship and clear protocols with signal shop for adjusting signal timing and monitoring the effectiveness of signal adjustments during an event.
- Visibility into maintenance shop assets (equipment/vehicles)
- Improve retention – implement explicit mentoring program for new HOTs

- Improve retention – implement suggested minimum observation time in SOC as part of hiring process
- Improve retention – implement round table interviews (vs. one-on-one)
- Improve retention – evaluate feasibility of pilot program for different types of shifts
- Improve retention – identify and evaluate feasibility of non-monetary benefits (e.g., daycare)
- Training – validate requirements for new/revised training programs and develop training development plan
- Training – develop and deliver Basic CHART training program (functional and application-based).
- Training – develop and deliver application-based training for Advanced Event Management and Special Event Management
- Training – develop and deliver application-based training for Reporting and System Administration
- Staffing expansion – 3 operators per shift; especially when TOCs are closed
- Staffing expansion – District 6

Note: No priority is intended by the order of the list below. A suggested timeframe for addressing each of these requirements (relative to the CHART system releases) was developed during the Release Strategy activities, and is provided in Appendix B. It is important that the suggested organizational change activities correspond to the releases since many of the system requirements assume that the impacted stakeholders are prepared to fully support the requirements (e.g., improved MSP stakeholder relationships and data sharing to be prepared for CAD 911 integration).

6 Location Model

The Location Model presents the vision, principles, constraints and assumptions that impact CHART's physical locations. It describes the types and locations of facilities and devices owned by the CHART organization. Further, the location model discusses the current characteristics of the locations and activities that take place at the various facilities. Finally, it provides recommendations on plans for future locations and the leveraging of new technology to provide more mobile CHART locations.

6.1 Location Direction

This section describes the vision; and key principles, constraints, and assumptions that guide the location and site selection for CHART operations.

6.1.1 Location Vision

The key vision statement for the future CHART locations, as described by the workshop participants, is:

CHART operations will all be virtual; our "office" is the State of the Maryland.

Specific examples of this are outlined below:

- There will be a TOC in every District (starting with District 5 and the Eastern Shore).
- CHART will expand to utilize existing signal systems to provide more capabilities and support to arterials/highways beyond interstates.
- CHART will better equip field operations to they can respond faster and more completely by providing field depots (closer to the field operations) to store equipment, provide shared office space for meetings, or even just a place to change a tire.
- CHART will provide 24 hour state-wide patrols.

6.1.2 Location Principles

- CHART will have distributed systems but will ensure that there is regional survivability (e.g., no single failure at one location will disable all locations).
- CHART will increase the number of locations (e.g., TOCs, partner sites, cameras), and methods for access (e.g., web, PDA) for providing and receiving CHART data.
- Each TOC will have one application for the control of all incoming and outgoing data.
- CHART tools will be available anywhere, anytime (virtual TOC).

6.1.3 Location Constraints

- CHART personnel must work within the security constraints of the MDOT network; and must not install any CHART software or devices at non-MDOT or CHART locations.
- New CHART access locations will need to consider the features and challenges of MDOT network access, and internet accessibility and security issues.

6.1.4 Location Assumptions

- The system will continue to provide the capability to transfer control between locations or centers.

6.2 Locations

There are three types of CHART and non-CHART locations. Each of these location types and the corresponding processes that are performed there are shown in the table below.

Figure 6.2-1 – CHART Location Types and Processes They Support

Location Type	Processes
Traffic Operation Center and Operational Support Facilities	Managing Events and Monitoring Traffic.
Field Devices	Monitoring Traffic, some Managing Traffic, and Providing Traveler Information.
Statewide Operations Center	Preparing for Events and Emergencies, Administering Systems, and Managing Performance

The following subsections describe the location type, specific locations for each type, and the how CHART is used at each location.

The map in the figure below shows some of the key SHA/CHART sites and facility locations including district offices, CHART server locations, and MdTA Centers.

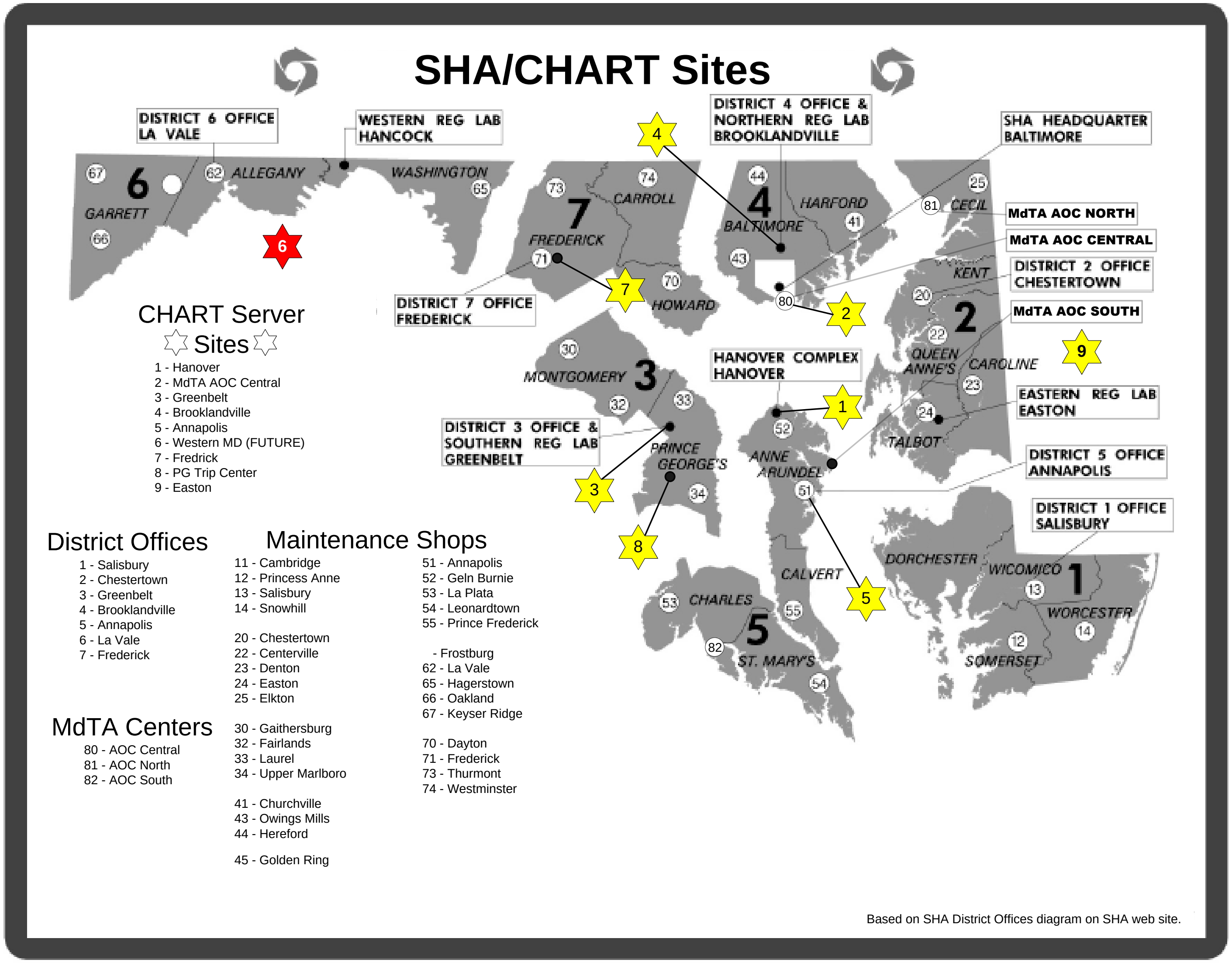


Figure 6.2-2 – SHA/CHART Sites

6.2.1 Traffic Operations and Support Facilities

There are eight location sub-types for traffic operations and support:

- Traffic Operation Centers
- Police Agencies
- SHA District Offices
- Media
- SHA/MdTA Highway Maintenance
- SHA Device Maintenance
- Regional Transportation Agencies
- Regional 911 and Emergency Operations Centers
- Data Processing/System Maintenance facilities (e.g., NOC, UMD CATT)

Each of these is described more fully in the paragraphs that follow. Note that in the future, new CHART mobile units may be considered "virtual locations".

Traffic Operations Centers – Provide system operations and traffic management services and are the primary system users and data input sources.

Center	Description	Location	CHART Use*
SOC	Statewide Operations Center	Hanover, MD	V, DE
AOC Central	Traffic Operations Center for MdTA toll roads and infrastructure (Central Maryland)	Fort McHenry Tunnel Vent Building, Baltimore	V, DE
AOC South (co-located with TOC 5)	Traffic Operations Center for the Bay Bridge and US 50 Corridor	MdTA Lane Bridge Police Barrack	V, DE
AOC North	I-95 and JFK Hwy	MSP Highway Barrack	
TOC 3	Traffic Operations Center for the Washington area	MSP Barrack Q, College Park,	V,DE
TOC 4	Traffic Operations Center for the Baltimore area	MSP Barrack R, Golden Ring	V,DE
TOC 6	Seasonally staffed center for Western Maryland snow removal operations – It is currently not a CHART video node, and is not staffed by CHART HOTs.	District 6 HQ, Cumberland, MD	DE or DM, depending on staff on duty
TOC 7	Traffic Operation Center for Frederick, Carroll	Frederick Law Enforcement Center,	V,DE

	and Howard Counties	Frederick, MD	
Ravens TOC	Traffic Operations for stadium events; only staffed for events	M&T Bank Stadium, Baltimore, MD	V, DE
Redskins TOC	Traffic Operations for stadium events; only staffed for events	Fed Ex Field, Landover, MD	V, DE

* V= Video user, DE= Data Entry, DM=Data Monitoring

Another operations center is planned: AOC North at Perryville, MD will service the I-95 corridor in northeast Maryland. It will have video and data entry capabilities. Another operations center for the eastern shore is desired..

Police Agencies – All Maryland State Police and local law enforcement departments participating in CHART provide traffic management and incident response support.

Name of Center	CHART Use*
Baltimore County Police HQ, Towson	V, DM
MSP A – Waterloo	V, DM
MSP F - North East	V, DM
MSP I - Easton	V, DM
MSP J – Annapolis	V, DM
MSP L – Forrestville	V, DM
MSP N – Rockville	V, DM
MSP P - Glen Burnie	V, DM
MSP V - Berlin	V, DM
MdTA Police Command Center,(FSK Police Facility), Dundalk	V, DM
US Park Police - Greenbelt	V, DM
MSP B – Frederick (co-located with TOC 7)	V, DM
MSP Q – College Park (co-located with TOC 3)	V, DM
MSP R – Golden Ring (co-located with TOC 4	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

District Offices – SHA District Offices primarily monitor and view information. They supervise highway maintenance and emergency operations, and coordinate the use of resources and personnel assigned to the Shops within the District..

Name	CHART Use**
District 5 Office, Annapolis	V, DM
District 4 Office, Brooklandville	V, DM

District 3 Office, Greenbelt	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

Media – These private and semi-private entities provide information to the public by obtaining filtered CHART incident and traffic flow information and CCTV video feeds.

Name	CHART Use*
Clear Channel Communications	V, DM
Traffic.COM	V, DM
Baltimore Media	V
Washington Media Outlet (co-located at MCTMC)	V
Traffic Land	V

* V= Video user, DE= Data Entry, DM=Data Monitoring

Note: CHART video is made available on the web by TrafficLand, but this is not implemented via the CHART network. CHART video feeds at the SOC are forwarded to TrafficLand's own networking equipment.

SHA Highway Maintenance Shops– These shops respond to CHART events and are responsible for structural repairs, road signs and posts, potholes, guard rails, etc.

Name	CHART Use*
SHA Annapolis Shop	V, DM
SHA Churchville Shop	V, DM
SHA Dayton Shop	V, DM
SHA Fairland Shop	V, DM
SHA Gaithersburg Shop	V, DM
SHA Golden Ring Shop	V, DM
SHA Hereford Shop	V, DM
SHA Laurel Shop	V, DM
SHA Owings Mills Shop	V, DM
SHA Upper Marlboro Shop	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

SHA Device Maintenance – There are two shops assigned responsibility for the maintenance and repair of traffic signals and ITS devices. The Signal Shop responds to signal outage events and requests to facilitate traffic flow related to incidents or congestion. The Signal Shop is located in the SHA Hanover Complex campus. The

Radio Shop responds to failures or operational issues related to devices such as HARs, detectors, CCTV cameras, RWISs, DMSs, ATRs, and SHAZAMs.

Name	Location	CHART Use*
Radio Shop	Catonsville, MD	V, DM
Signal Shop	Hanover, MD	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

Regional Transportation Agencies – CHART connectivity has been extended to a number of regional transportation entities identified in the following table. While these agencies are themselves involved in traffic management and signal operations, they do not function as TOCs within CHART. Their connectivity with CHART is to facilitate inter-agency/jurisdictional traffic data and video sharing. Users at these sites are not CHART operators.

Name	Location	CHART Use*
Anne Arundel County Department of Public Works and Transportation (AA DPWT)	Annapolis, MD	V, DM
District of Columbia DOT	Washington, DC	V, DE, DM
Montgomery County Traffic Management Center (MCTMC)	Gaithersburg, MD	V, DM
Prince George's County TRIP Center	Forrestville, MD	V, DE, DM
Virginia DOT Smart Traffic Center	Arlington, VA	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

Regional "911" and Emergency Operations Centers – these include all participating County 911 Centers, the Maryland Emergency Management Agency (MEMA), and the Maryland Institute for Emergency Medical Services Systems (MIEMSS).

Center	Location	CHART Use**
Anne Arundel County 911 Center	Millersville, MD	V, DM
Harford County 911 Center	Forrest Hill, MD	V, DM
MEMA	Reisterstown, MD	V, DM
MIEMSS	Baltimore, MD	V, DM
Baltimore County 911 Center	Towson, MD	V, DM
Howard County 911 Center	Ellicott City, MD	V, DM
Frederick County EOC	Frederick, MD	V, DM
Talbot County 911 Center	Easton, MD	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

Data Processing/System Maintenance Facilities – These centers have no operational functionality, however they process CHART data or have system maintenance responsibilities.

Name	CHART Use**
CSC NOC, Hanover, MD	V, DM
University of Maryland CATT Lab, College Park, MD	V, DM

* V= Video user, DE= Data Entry, DM=Data Monitoring

6.2.2 Locations – Field Devices

There are several types of field devices that are used to monitor traffic and roadway conditions and provide traveler information (for more information on device types, refer to Section 9, Technology Model.) The location of each device is determined by several factors including roadway importance (e.g., amount and criticality of traffic flow), type of data that it provides and to whom.

Currently over 150 roadway condition, traffic flow, and environmental monitoring devices are installed in strategic locations across the state. Similarly, over 120 traveler information devices (e.g., DMS, HAR) display or broadcast traffic conditions and other information to the traveling public on key Maryland roadways. Connectivity to theses devices is primarily through leased circuits or direct connection to a CHART site (e.g., RTMSs at Wilson Bridge).

In general, the devices are installed on interstate and major roads in the most populated regions of the state, and are generally installed on state right-of-ways (land owned by the state). In the future, CHART would like to get data from more devices in less populated areas such as eastern shore and western Maryland and on major secondary routes such as Route 1 and Route 40. The data may be from new SHA devices (although there are only limited plans for this) or from devices owned and operated by regions or private third parties. CHART has currently begun integrating devices owned and maintained by local regional transportation agencies (e.g., Harford County cameras, Anne Arundel County cameras, and Prince George's County cameras).

In the future the meaning of the term "field devices" may expand to include non-fixed-location devices such as cellular phones and toll tags that passively provide traffic data to CHART. It may also include "virtual locations" such as mobile units with full or partial functionality with access via WiFI or cellular communication.

6.2.3 Locations – Statewide Operations Center (SOC)

Activities at the SOC, located at the SHA Hanover Complex, are primarily focused on CHART management and planning. Examples include preparing for events and emergencies, administering CHART systems operation and development, and managing performance.

Regarding the location of CHART system administration functions, a requirement to distribute system functionality and redundancy to ensure regional survivability was reiterated during the workshops. These requirements are being addressed as part of other CHART system architecture initiatives.

6.3 Location Recommendations

The key areas for location changes include:

- Facility and staff expansion in TOC 7.
- New facilities on the Eastern Shore (District 1 or 2).
- Improved facility design at police barracks and district offices to facilitate improved communication and coordination between CHART operations and the local facility activities.
- Depots for field operations.
- Additional field device locations (e.g., more SHA or privately owned detectors and cameras) and device types (toll tags and cellular probes).

Although current constraints for CHART locations to have connectivity to the network have previously been defined as direct physical connectivity (or VPN access) to the MDOT network, three new ways of connectivity are evolving:

- Facilities on the MDOT network
- Connectivity to the MDOT network for the purpose of using CHART.
- Connectivity via the Internet (future).
- Wireless connectivity for field units and command buses (future).

A suggested timeframe for addressing each of these recommended Location requirements was developed during the Release Strategy activities. Each of these requirements and the general timeframe in which it should occur (relative to the CHART releases) is provided outlined in Appendix B. It is important that the Location change activities correspond to the releases since many of the software requirements assume that the impacted stakeholders are prepared to fully support the requirements (e.g., network connectivity to integration sites).

7 Data Model

Providing complete and accurate data to CHART users, traffic management analysts, stakeholders, and the traveling public is critical to CHART's success. The Data Model direction (Section 7.1) provides the guidelines and requirements to support this. The Data Current State (Section 7.2) describes the current logical data components and their physical distribution across CHART databases; and issues with the current data quality, quantity, and distribution. The Data Recommendations (Section 7.3) describes the key areas of improvement in CHART data management (e.g., new data requirements, standardization, and quality control).

7.1 Data Model Direction

The Data Model Direction outlines the vision, and the principles, constraints, and assumptions that guide optimum data management, data quality, and data accessibility for CHART.

7.1.1 Data Vision

The key vision statement for the vision for the future CHART business processes, as described by the workshop participants is:

Data from more sources; seamless to users

Specific examples of this are outlined below:

- CHART will reduce the burden of determining what data may be required from other from other providers' systems be allowing them to provide simple data dumps and let CHART prescribe the filters for what CHART needs to know.
- CHART will be able to import/integrate external traffic data without operators knowing or caring about the source (but it will be marked with the source so operators can gauge validity).
- The public regularly commutes across multiple jurisdictions and will neither know nor care "who is responsible" for notifying them of backups and cleaning them up. They will just get the information they need when they need it; irrespective of its source.

7.1.2 Data Principles

- CHART will be able to segregate and protect privately owned and sensitive data.
- Access to CHART data will be provided to appropriate CHART operational users (internal) and external stakeholders.

- The CHART system will support integration of data from internal/external systems in support of CHART business processes. (see also Application principles)
- Data will be entered once, at the source (single entry of data).
- Data must be entered accurately (or validated where possible) at the source so the data quality is high; CHART must be a trusted data source.
- The CHART interface design will minimize data entry and improve data quality by providing pick lists that can be modified by a CHART system administrator, and limiting the number of free-form text fields to the type of data that needs to be in that format (e.g., is not easily codified).
- There will be near real-time distribution of incident, device, and system status.
- The system must leverage/share appropriate incident information with CHART partners in accordance with in-place agreements.
- The system must be able to retrieve and distribute (import/export) non-CHART external data.
- The data architecture must support pre-defined and ad hoc reporting.
- The system must log all operator actions.
- Traffic monitoring and roadway condition data will be collected and stored (including all data from devices) in support of CHART business processes.
- The system will allow event-driven overrides (e.g., event message signs that need to be updated) and will log the operator actions.

7.1.3 Data Constraints

- CHART must use SHA GIS data for location-related data.
- All data collection and analysis must conform to all appropriate national ITS standards.

7.1.4 Data Assumptions

- Data will be available from other/external systems.
- CHART will need to accept and process data in a variety of formats; e.g., travel time, origin/destination, and queue lengths for traffic backups.
- CHART will validate sensor data as appropriate.
- CHART will not provide direct access to its database from external sources but will provide database views when applicable.

7.2 Data Current State

There are two primary elements related to understanding the current state of CHART data:

- The logical subject areas of the data
- The physical distribution of data across the CHART databases

Each of these is described in more detail in the sections below (7.2.1 and 7.2.2, respectively. Section 7.2.3 describes the key issues and opportunities for improvement on the current CHART data.

7.2.1 Logical Subject Areas of CHART Data

The CHART application uses a wide variety and high quantity of data. This data is organized by two major functional areas each consisting of several subject areas:

- Operations
  - Plans
  - Map
  - Events
  - Resources
  - Devices
  - Library/Dictionary
  - Logs/Status
- System Administration
  - Users
  - Archive
  - Exportable Data
  - Reports

The relationship of each of these subject areas is shown in the figure below. The individual boxes on the picture are subject areas that represent a group of data that is broken down into specific entities. The large shaded boxes behind the subject area boxes represent the functional use of these areas: Operations and System Administration. The lines drawn between the subject areas indicate a relationship between them. Dotted lines indicate that the relationship is optional; solid lines indicate that the relationship is mandatory.

Each of the data subject areas shown in the figure is described in more detail in the paragraphs that follow.

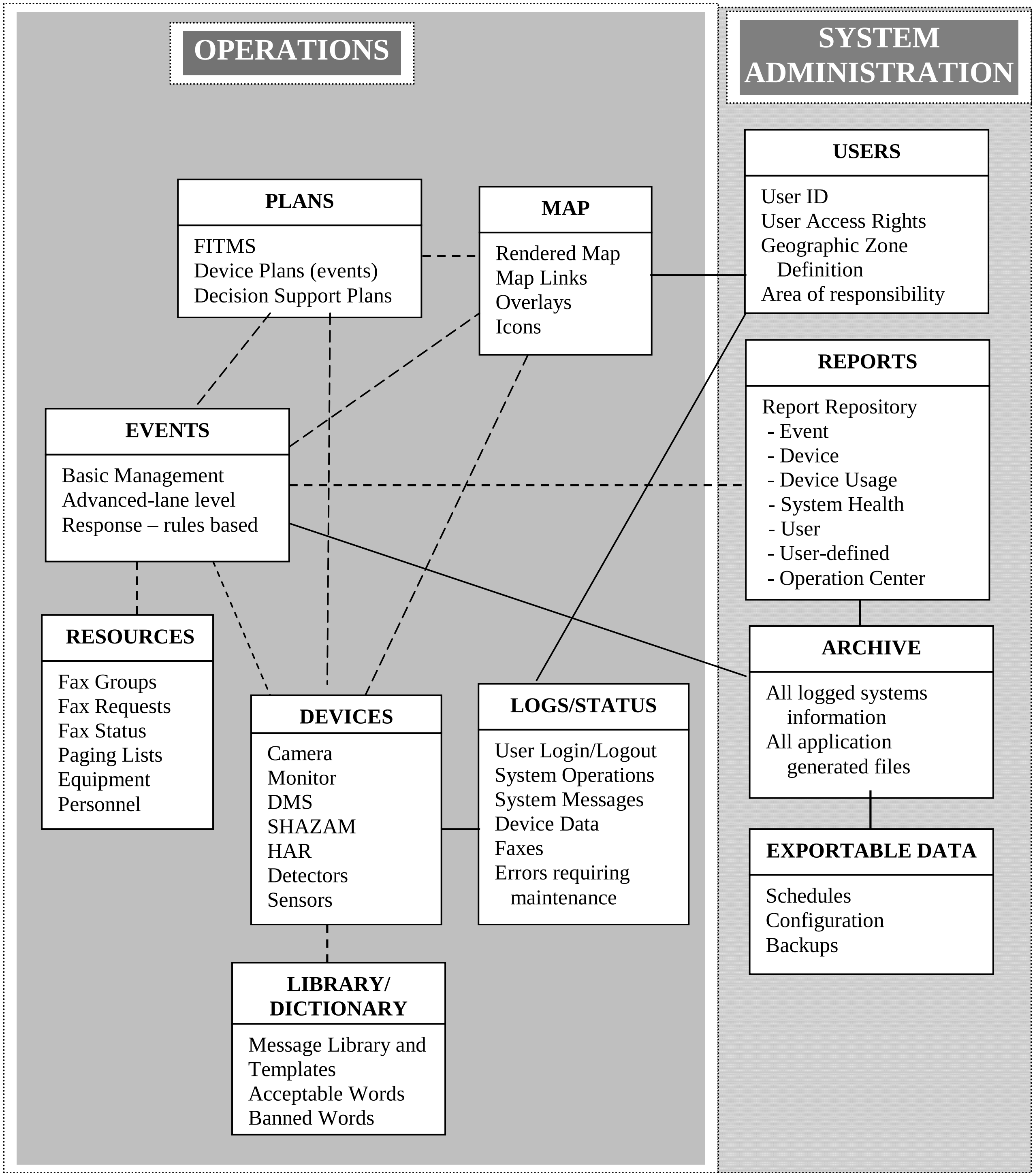


Figure 7.2.1-1 – Subject Areas of CHART Data

7.2.1.1 Operations Functional Area

The Operations functional area consists of data that provides the user and system the data needed to process the day-to-day operations of the CHART system, including event management. Each of the specific subject areas in this functional area is described below.

- **PLANS -** CHART is organized by plans and rules, including FITMs, device plans (for event response), and decision support plans. The plans are related to the MAP, DEVICES and EVENTS (optionally). This means a plan may be related to events, devices, and the map based on a specific occurrence, but a plan can exist separately.

- **EVENTS** – Event management contains basic and advanced lane level management parameters, as well as rules-based responses from implemented decision support plans, device activation, or another operator action. This subject area is directly related to the ARCHIVE, and is optionally related to PLANS, DEVICES, MAP, REPORTS, and RESOURCES. The optional relationship indicates an event can exist without a plan.

- **RESOURCES** – This subject area organizes the communications information regarding both the appropriate parties to fax or page and the equipment resources to be located when the rules are activated to handle an event. It is optionally related to EVENTS.

- **DEVICES** – This subject area contains the cameras, monitors, DMSs, SHAZAMs, HARs, sensors, and detectors. Since they are not currently an integrated part of CHART, weather and environmental sensors (e.g., SCAN devices) provide data that is displayed (but not stored) in CHART. In the future, signal data, and AVL data will also be included in DEVICES. The three categories of devices are video, audio, text and detectors. Video is not stored in the database. Audio, text messages and detector measurements will be stored. At each district, only the operational device information for that district will be stored. DEVICES are optionally related to PLANS, EVENTS, LIBRARY/DICTIONARY, and MAP (currently a separate database), and is directly related to LOGS/STATUS.

- **LIBRARY/ DICTIONARY** – This subject area includes the message library and templates, and the dictionary of acceptable and unacceptable words. It is optionally related to DEVICES which means that the messages and dictionary contents can exist without being assigned to a device.

- **LOGS/STATUS** – This is a group that covers many types of logs from the communications log to device status. This subject area is related to the DEVICES since the results of all actions regarding the device output are logged and eventually posted into the ARCHIVE. There is also a relationship to REPORTS. The USERS subject area is related since key users input and actions are logged.

- **MAP** – This subject area contains the data for the rendered map as well as map links, overlays and icons. It is related to the USERS regarding geographic zone and area of responsibility. The MAP is also optionally related to the PLANS, EVENTS, and DEVICES. This means that all three subject areas may exist without each other, but could also be related based on a specific occurrence.

7.2.1.2 System Administration Functional Area

The System Administration functional area consists of subject areas related to CHART user management and the archiving and reporting functions. Each of the specific subject areas in this functional area is described below.

- **USERS** – This subject area includes user profiles and access rights. It also contains the operations center to which the user is logged onto which implies an area of responsibility. It is related to MAP and LOGS/STATUS.

- **REPORTS** – This subject area includes the pre-defined reports generated using the reporting tool which extracts data from the ARCHIVE, EVENTS and LOGS/STATUS.

- **ARCHIVE** – This subject area includes data from the CHART operational system as part of a permanent archive. The CHART Archive database design is a copy of the CHART operational system for those tables containing system and event log information. In addition, the CHART Archive database stores detector data. This data is stored as time annotated averages at selected frequencies. The archive is a completely separate database. There is a relationship to LOGS/STATUS and REPORTS.

- **EXPORTABLE DATA** – Defines schedules and configuration for exporting data sets from the archive. It relates to the ARCHIVE.

7.2.2 Physical Distribution of Data (CHART Databases)

CHART data is currently stored in one or more of the following database types:

- CHART database –This database supports the real-time CHART application.
- CHART Mapping database – This database supports the CHART Mapping application.
- CHART Archive database – This database stores archive data generated by the CHART application.
- CHART Mapping Archive database – This database stores archive data generated by the CHART Mapping application.

Note: In addition to the CHART databases, the EORS and RWIS databases provide data to CHART.

Each of the CHART databases is briefly described in the paragraphs that follow.

The subject areas described in the previous subsection are distributed in these database types in the schema shown in the table below. An "X" in the "Stored in Database Type(s)" column indicates that data in that subject area is stored on that database type.

Figure 7.2.2-1 Subject Areas Stored in CHART Databases

Subject Areas	Stored in Database Type(s)		
	CHART	CHART Mapping	CHART/ MAP Archive
Operational Functional Area			
Plans	X		
Events	X	X	X
Resources	X		
Devices	X	X	
Library/Dictionary	X		
Logs/Status	X	X	X
Map		X	
System Administration Functional Area			
User data	X		
Reports	X		X
Archive			X
Exportable Data			X

7.2.2.1 **CHART Database**

This is the operational database for the CHART application. It stores the operations and system administration data described above with the exception of the MAP and ARCHIVE subject areas. Data concerning both open and recently closed traffic events is retained in this database to be made available to the CHART operator using the application. Information concerning closed traffic events is aged and eventually archived to the CHART Archive database.

To maximize local functionality during outages, the CHART database is co-located with the CHART application on the application server. There are seven instances of CHART databases distributed across the State. Two more are planned as CHART moves into the Eastern Shore and Western Maryland.

7.2.2.2 **CHART Mapping Database**

This is the operational database for the CHART Mapping application. This database stores data for the EVENTS and MAP subject areas, including information to display traffic, roadwork, roadway weather, video/snapshot images, and CHART device information on the CHART internal and external web sites. It stores geo-location information for the EVENTS and DEVICES subject areas.

7.2.2.3 **CHART Mapping Archive Database**

This database stores historical geo-location information about EVENTS. When traffic events are closed, data about event basic information and location on the map is saved in this database, to provide a historical view of where traffic events were at any particular time.

7.2.2.4 **Archive Database**

Archiving is a function that allows large amounts of information to be stored for later purposes. The primary uses of archived information are:

- Information used for generating various reports.
- Information available for other Maryland state agencies.
- Information used for CHART simulation.
- Information available for legal purposes.
- CHART historical data repository

Currently CHART maintains an 8-hour set of data for use by the online operational parts of the system (this time limit is configurable). Data older than this is designated to be archived (unless it is related to an open event which is never archived until it is closed). At the end of each day two main events occur:

- The data designated to be archived is copied from the operational database to the archive database (there is never more than a 24-hour lag in data).
- The data that has been archived is deleted from the operational database (except for open event data which is updated in accordance with business rules described below).

The data in the archive database includes:

- Camera Tour data
- Camera/monitor display activity data
- Camera control activity data
- Center data
- CHART Map data
- Weather and Event Temperature data
- Detector data
- Device and Status data (e.g., DMS, HAR, TSS)
- Event data (including lane state, Action, event type code, vehicles, disabled vehicle indicator, associated event)
- Event History data
- Event Resource (resource type, category) data

- Operations Log data
- Communications Log Data
- Communications Failure Log
- Plan
- Scheduler
- Sensor data
- System Parameter
- User

The business rules currently governing archiving require that before any data from events can be transferred, the database must be analyzed for changes:

- Events that have been closed since the last update and have aged long enough that they are able to be archived, are moved to the archive.
- Events that remain open are not moved to the archive.

7.2.3 Replication of CHART Databases

The databases provide replication of all entities required for a CHART server site to run independent of any other CHART server site, as might occur with a network outage between sites. This replicated data includes the system profile, organization, CHART GUI, user management, and dictionary entity data. The data related to communications logging and resources is replicated as well. Device configuration data is not replicated since each device is homed to only one server. Similarly, traffic event information is homed to only one server and therefore not replicated. This could be considered a single point of failure if the servers become unavailable. Additional ways of distributing the data should be considered part of future failover analysis.

7.2.4 Issues and Opportunities for Improvement

There are three primary areas of data management issues and opportunities for improvement:

- Data quality
- Data quantity
- Data distribution and archiving

Each of these is described in the subsections that follow.

7.2.4.1 Data Quality Issues

There are three key areas of data quality issues.

- Invalid or incomplete data entered by users. Examples:
  - Free-form text fields that allow inconsistent or wrong data to be entered in the system; “I-495” vs. “495” vs. “Beltway”.
  - Optional fields that allow the user to skip over data that really should be mandatory.

- Invalid or incomplete data from detectors and sensors. Examples:
    - Speed detector data that says traffic is moving at 150 mph at 8:00 AM on I-495).
    - Corrupted detector data that cannot be read into CHART - speed data for that location is absent.
    - Sensor reports temperature that is significantly different than all other sensors in the same region. (But I don't known if this data is archived in CHART)

- Invalid or incomplete data from interfacing systems. Examples:
    - Missing phone numbers for on-site point of contact for construction permits.
    - Conflicting or duplicate permits which could result in broadcasting and displaying incorrect messages to the traveling public such as "road closed" when it is not; and/or result in worsened traffic conditions if multiple contractors are working in the same area.

7.2.4.2 Data Quantity Issues

In some cases CHART has more data than can be viewed or managed. As an example, there are long, cumbersome lists that are difficult to navigate such as the device plans list. Also, many devices are capable of providing more data than they are currently configured to provide, or they are currently provide this data but CHART does not capture or store it.

In some cases CHART does not receive enough data for operators or the traveling public to make good decisions. As an example, the CHART system does not get as much useful device data as they would like; especially on the whether the device is working properly (e.g., the system says the message is displayed but it's really not). CHART needs:

- More data (e.g., additional devices for speed data and travel times, mean time between failures, mean time to repair, additional data from third parties, frequency and length of camera usage related to their use in event management, and the frequency and types of out-of-service conditions).
- Data that is more accurate (e.g., validated speed data, scene clearing time).
- Different types of data (e.g., direct speed data vs. a calculated average, performance data to promote the benefits of CHART).

CHART data needs to include more information about who was notified and who participated in an event and for how long. This will allow CHART to keep track of when they were notified/dispatched, arrived, departed, etc. Example: CHART drivers do not receive sufficient credit for their participation in incident response. From the planning perspective and maintenance perspective, better data on their participation would facilitate more efficient field unit routing, scheduling, equipment tracking, and resource usage.

7.2.4.3 Data Distribution Issues

For the most part, the physical data distribution schema depicted above is working well. However, two areas of improvement were identified:

- Better distribution of device control to TOCs for improved failover/redundancy.
- Improved management of archived data.

Currently all DMS and HARs are configured and managed on servers at the SOC and AOC. This data needs to be distributed to other CHART servers (as cameras and monitors are currently) to reduce the dependency on the SOC and AOC. This will also hold true for new device types such as probes and AVL.

With respect to the archive there are issues with extracting data for reports and with the size of the archive. Currently some reports require extracting data from multiple database types. This constrains ad hoc reporting capability and timely production of the current pre-defined reports.

The size of the archive is also of concern because the archive data is growing without bounds. There are currently no clear protocols or procedures to move archived data from the archive database for long-term data storage/management.

7.3 Data Recommendations

There are three primary areas for improvement in CHART data management. They correspond to the three primary areas of data management issues and opportunities for improvement discussed in the previous section. Note: No priority is intended by the order of the list below.

- Data quality improvements
  - Standardization of existing data formats, and standardization of definition of data (e.g., consistent definitions of "event types", and what constitutes "congestion" - especially with what is supported with RITIS and other data providers).
  - Improved quality control of data from sensors, detectors, and interfacing systems.
  - Improved quality control of data entered by CHART users.
- Data quantity improvements
  - Better organization of lists; sort, search capabilities.
  - Addition of new data types to support new/enhanced CHART processes.
- Data distribution and archiving improvements
  - Improved data distribution for device management and failover/reliability.
  - Improved management of archived data.

7.3.1 Data Quality Improvements

To improve the quality of data entered by users, the following changes are recommended:

- Make specific fields mandatory
- Provide more error-checking
- Provide more pulldown menus and fewer text entry fields
- Provide "smart" ways for the system to fill in data; e.g., automatically mapping an event to get correct latitude and longitude, adding date/timestamps for event activities vs. having the operator record it
- Have the system flag or eliminate suspected bad data from devices and sensors, and from interfacing systems

Not only will using more pulldowns improve data consistency, but in conjunction with using standardized formats in accordance with Traffic Management Systems Data Dictionary (TMDD) guidelines, improved data sharing with other traffic management organizations (i.e., center to center interfaces) will be facilitated. This supports two of the key data principles described in Section 7.1:

- The CHART system will support integration of data from internal/external systems in support of CHART business processes. (see also Application principles)
- All data collection and analysis must conform to all appropriate national ITS standards.

7.3.2 Data Quantity Improvements

The most significant area of improvement in data quantity is to create the additional data elements to support the enhanced/new processes outlined in the Process Model section (Section 4). The specific new data requirements and the specific processes to which they correspond are listed in the table below.

Figure 7.3.2-1 New Data Required for Processes

New Data Requirement	Processes that Create or Use the Data
Areas of Responsibility	1.1.1.2 Maintain Geographic Areas of Responsibility 4.1.1.1 Specify Location and Impact [of Event] 4.1.2.2 Evaluate Event Response Recommendations 4.1.2.3.1 Select/Deselect Resource or Device 4.1.2.3.4 Adjust Camera Parameters and Monitor Assignment 4.1.2.4 Execute Course of Action
Organization Type	1.1.1.1 Maintain Organization Types 4.1.2.2 Evaluate Event Response Recommendations 4.1.2.3.1 Select/Deselect Resource or Device 4.1.2.4 Execute Course of Action

New Data Requirement	Processes that Create or Use the Data
Last Accessed userid and date/timestamp	1.2 Maintain Message Libraries 2.3.3 Maintain Device Plans 4.1.2.2 Evaluate Event Response Recommendations [DS Plan] 4.1.2.4 Execute Course of Action [DS Plan]
Map Layer Types, Road Aliases, Mile Markers with Corresponding Exit Numbers	1.3 Maintain Map (download, select layers, modify road names) 2.3.2 Identify Roadways for Signal Control and Travel Time 4.1.1.1 Specify Location and Impact 4.1.2.1 Verify Event Location and Specifics
Shift handoff acknowledgement (userid and date/timestamp)	1.4.2 Perform Shift Handoff (incoming)
Default Event Control Transfer Center (in case of quick evacuation, automatically transfer events/devices to designated TOC/SOC)	1.4.5 Control Logout and Transfer Control
New device type = probe	1.5.1 Install Equipment/Devices 2.4 Define Alert Criteria
Probe Source Type (MTAC, E-Z Pass, MDOT vehicle, MSHA vehicle, cellular)	1.5.1 Install Equipment/Devices 3.1 Detect Conditions 3.2 Record Conditions
Decision Support Plan data (name, description, created by userid and date/timestamp, status; associated devices, resources, equipment)	2.1.1 Name Decision Support (DS) Plan 2.1.6 Set DS Plan Status 2.2 Simulate Emergencies and Other Scenarios 4.1.2.2 Evaluate Event Response Plan Recommendations 7.4 Simulate CHART Operations and Traffic Management Performance
Equipment Type, Status (e.g., in-service) and Default and Current Location (using AVL); e.g., for FITM trailers, front-end loaders	1.5.1 Install Equipment/Devices 2.1.4 Associate Notifications and Resources [Equipment] to DS Plan 4.1.2.3.1 Select/Deselect Resource or Device 4.1.2.4 Execute Course of Action 4.2.1.1 Monitor Resource Status
Alert Criteria/Conditions	2.1.2 Select DS Plan Conditions 2.4 Define Alert Criteria 3.3 Issue Alert or Post Information
Point of Contact Notification data (e-mail, phone, fax)	2.1.4 Associate Notifications and Resources to DS Plan 4.1.2.4 Execute Course of Action
Alternate Route data (associated with roads, created by userid and date/timestamp, status)	2.1.5 Associate FITM or Alternate Route [to DS Plan] 2.3.1 Maintain Roadway Plans – FITMs and Alternate Routes 5.2 Recommend Alternate Routes 6.1 Broadcast Information 6.2 Maintain [External] Web Site Information 6.3 Provide Recorded Information
Designation for Signal Control and	2.3.2 Identify Roadways for Signal Control and Travel Time

New Data Requirement	Processes that Create or Use the Data
Travel Time Use (applied to roads and devices)	3.3 Issue Alert or Post Information (e.g., travel time) 4.2 Respond to and Monitor Event (e.g., calculate queue length) 5.1 Control Signals and Roadway Access 5.3 Calculate Travel Time 6.1 Broadcast Information
New status for event = "Scheduled"	2.5 Schedule Events
Alert Acknowledgment (userid and date/timestamp)	3.4 Receive and Respond to Alert
Event Source Code	4.1.1.4 Identify Event Source 4.1.2.1 Verify Event Location and Specifics
Changes to current "Standard Lane Configuration" to accommodate non-standard for dynamic lane configuration (e.g., at tolls, lane reversal)	4.1.1.1 Specify Location and Impact 4.1.2.1 Verify Event Location and Specifics 4.1.2.4 Execute Course of Action 4.2.1.2 Monitor [Event] Activities
Add new Lane State attribute for "Lane Direction Travel – Temporary" to account for lane reversal during incident management	4.1.2.4 Execute Course of Action
Event Reference/Charge Numbers	4.1.2.3.2 Enter Event Reference/Charge Numbers (e.g., AR/IR number from police or SHA charge number)
New status for Event Resource = "In Route" (with date/timestamp)	4.1.2.4 Execute Course of Action 4.2.1.1 Monitor Resource Status 4.2.1.2 Monitor Activities
New statuses for Camera = activated for event and deactivated for event (to capture frequency and length of usage	4.1.2.4 Execute Course of Action 4.2.1.1 Monitor Resource Status 4.3.4 Record Event Closure

7.3.3 Data Distribution and Archive Improvements

For improved data distribution, there are requirements to shift device ownership back to the appropriate corresponding area of responsibility, and to review the current failover and redundancy protocols, and the equipment needs to support the requirements (this is scheduled to be addressed in a future CHART task).

As noted above, the size of the archive is also of concern because the archive data is growing without bounds. There are currently no clear protocols or procedures to move archived data from the archive database for long-term data storage/management. For improved archiving, further study should include a review of the requirements and business rules for the following:

- How much and which types of data need to be archived?
- What does CHART need in real-time (e.g., device status)?

- What does CHART need available in near real-time (e.g., user login/out times, management reports)?
- What can CHART wait to get (e.g., device failure history)?
- Should we establish an off-line archive for long-term storage of the old data? (and if so how long would data be held in the "online" archive?

8 Application Model

This section presents the direction for advancing the software applications of the CHART organization. It describes the:

- Application direction in terms of the CHART vision for the future application, and the principles, constraints and assumptions that guide future CHART software application development and integration (Section 8.1).
- Current application components, and current and planned system interfaces (Section 8.2).
- Application approaches for improving the user interface and the application architecture to optimize CHART performance (Section 8.3).
- Application recommendations for implementing the application approaches (Section 8.4).

With respect to application deliverables for future releases, Appendix C provides a table that cross references the Maryland State SDLC, CHART RFP, and the recommended CHART deliverables.

8.1 Application Direction

The Application Direction outlines the CHART vision for the future application, and the principles, constraints, and assumptions that guide future CHART software application development and integration.

8.1.1 Application Vision

The key vision statement for the future CHART application, as described by the workshop participants is:

Increased usability, and more automation, integration, and intelligence

Elements of this vision are addressed in the Application Approach section (8.3). Specific examples of this are outlined below:

CHART will provide incident management fusion such that the system:

- Knows who needs what info and routes it appropriately (e.g., automatic notifications for fax and page, automatic “event [still] open” alerts with snooze).
- Automatically keeps track of the age of the data (so users know what’s current).
- Supports standards-compliant intra-system messaging.
- Automatically opens a CHART event with lane closures upon roadwork activation.
- Provides an alert capability to let operators know when something needs their attention.

- Provides automatic sign/DMS suggestions for major events based on location and direction.
- Provides an event and device scheduler.

CHART will integrate its systems and equipment with current systems and new external systems in support of reducing recurring and non-recurring congestion and increasing the safety of the traveling public. This includes, but is not limited to:

- Providing regional integration with RITIS.
- Integrating cameras with those of other agencies.
- Providing automatic mapping, automatically programmable HARs and DMSs, automatic weather alerts, automatic paging, and automated incoming data collection.
- Integrating AVL into CHART.
- Providing traffic control signals status and monitoring.
- Monitoring and limited control of lane use signals and traffic signal timing.

CHART will be able to predict congestion and push response ***before*** it happens using location, time, current roadway conditions, weather, and other factors (e.g., prior incident patterns) based on historical data.

8.1.2 Application Principles

The following guiding principles will govern the software engineering of future releases of the CHART application software. The future CHART application will:

- Not be just an event management system. It also provides timely roadway condition monitoring, pre-notification of construction activities, a map for viewing roadway status and events, and a website to provide real-time information to the traveling public.
- Start by reviewing current systems and requirements.
- Provide a balance of mission needs, limited resources, and technology with a realistic view that other requirements will creep in.
- Employ modular program design for the CHART software.
- Employ a distributed design for the CHART software to increase fault tolerance.
- Provide a flexible design to accommodate functional expansion of devices, new features, and new graphical capabilities.
- Move towards providing a common user interface for all functions, including legacy systems.
- Develop the user interface to maximize ease of use by operators and general users.
- Have an easy-to-use interface for system configuration and system administration
- Not allow unauthorized access to functions and data.
- Employ standard principles of good application design (e.g., all user actions include feedback/confirmation: “Are you sure you want to delete?” and “Device configuration successfully updated.”).

- Use short-cuts or other methods to minimize user steps to accomplish system functions.
- Automate system maintenance activities to the extent possible.
- Use sound engineering principles and take into account equipment, communications, network, etc.

Additionally, the following principles will govern the application itself: The future CHART application will:

- Support integration of data from internal/external systems in support of CHART business processes (see also Data principles).
- Combine other systems' functionality in CHART; one-stop data entry.
- Provide a seamless outflow of traffic information to the public (e.g., web site) and private sector (e.g., access to CHART video and data).
- Provide more flexible capabilities to modify lane configuration and update status (e.g., at toll plazas, for roads with two-way operations, on/off ramps in both directions).
- Allow for device control from any appropriately authorized CHART user.
- Notify the user of preset alarms.
- Self-monitor and attempt self-recovery.
- Automate traffic control and traveler information devices as part of event workflow.
- Simulate and preview operator actions.
- Provide Section 508 compliance on an on-going basis. [This refers to Section 508 of the Rehabilitation Act which requires electronic and information technology be accessible to persons with disabilities.]

8.1.3 Application Constraints

The above principles help to guide CHART's development but, as in any software engineering project, challenges exist which can hinder its success. These factors can make it difficult to adhere to the principles discussed above, and thus impede CHART's ability to reach its goals. Some of CHART's constraints are:

- The mission needs of SHA will continue to expand.
- Their will be times when in addition to meeting its own requirements, CHART will have to address the requirements of other external organizations.
- Application development must be approved by the Department of Budget and Management (DBM).

8.1.4 Application Assumptions

In addition to the guiding principles and limiting constraints, certain important assumptions are built into achieving CHART's goals. These assumptions represent risks for CHART if they are either not true or not met. These assumptions are:

- CHART system development will build on existing software rather than starting anew.
- CHART system development will apply open architecture design principles, and sound application development principles (e.g., object-oriented design) whenever possible.
- The CHART system will conform to all appropriate national and state ITS standards. (Appendix E outlines the applicable national and state ITS standards for CHART.)

8.2 Application Components and External Interfaces

The preceding description of CHART's overall application direction focuses on the future development of the next generation of CHART software. This section describes CHART application components and system interfaces.

8.2.1 CHART Application Components

The relationship between the CHART components is depicted in the diagram below. The CHART application consists of four major components; each of these components is described briefly in the table that follows.

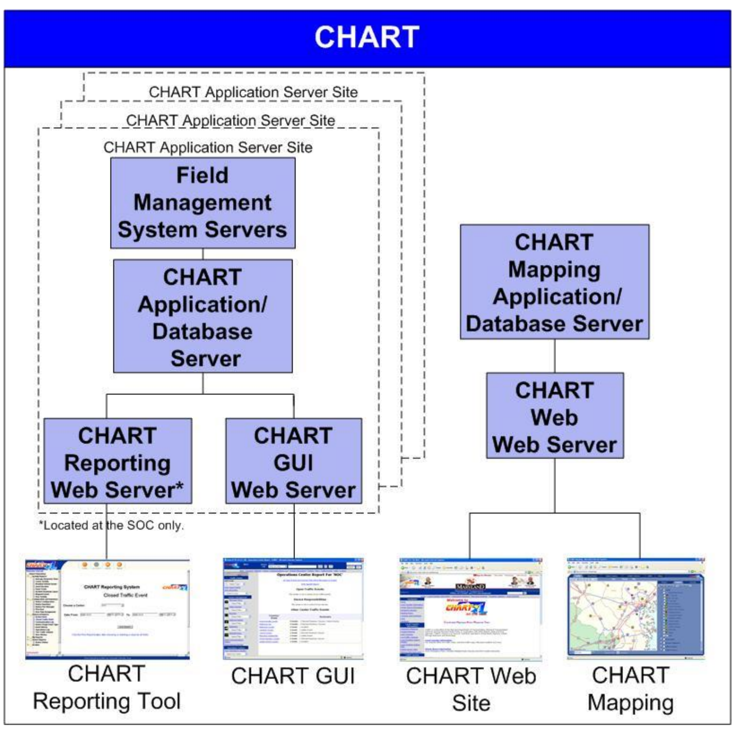


Figure 8.2.1-1 CHART Application Component Relationships

Figure 8.2.1-2 CHART Application Component Descriptions

Application Name	Description
CHART GUI	CHART is the Coordinated Highways Action Response Team - Maryland State Highway Administration's statewide Advanced Traffic Management System (ATMS). CHART is a distributed system. The GUI is web-based technology. CHART uses web servers for servicing the GUI, field management system servers to collect data from and command field devices, and application/database servers for server-side processing.
CHART Mapping	The CHART map is a CHART software application that displays CHART events, device locations and status on a map-based user interface. The CHART mapping tool is not integrated into the CHART software. It is a separate application that displays data obtained from CHART. There is an internal mapping capability tailored for use by CHART operators and an external mapping capability provided to the public through the CHART web site.
CHART Reporting Tool	The reporting tool is a query-based database reporting tool used to obtain historical and statistical data from the CHART data repositories (operational and archive). The tool is web-based technology using a web server for servicing the GUI and and application/database servers for accessing CHART operational and archive data.
CHART Website	This is a public access website for disseminating CHART video and traffic condition data to the traveling public.

8.2.2 CHART System Interfaces

The CHART application functionality and usefulness is enhanced and broadened by accepting additional data from and providing additional data to numerous related external systems. The figure below shows CHART’s current and potentially future external interfaces to other systems. It also shows external interfaces expected to come to CHART through RITIS. The specific interface architecture for many of the new interfaces will be determined during design.

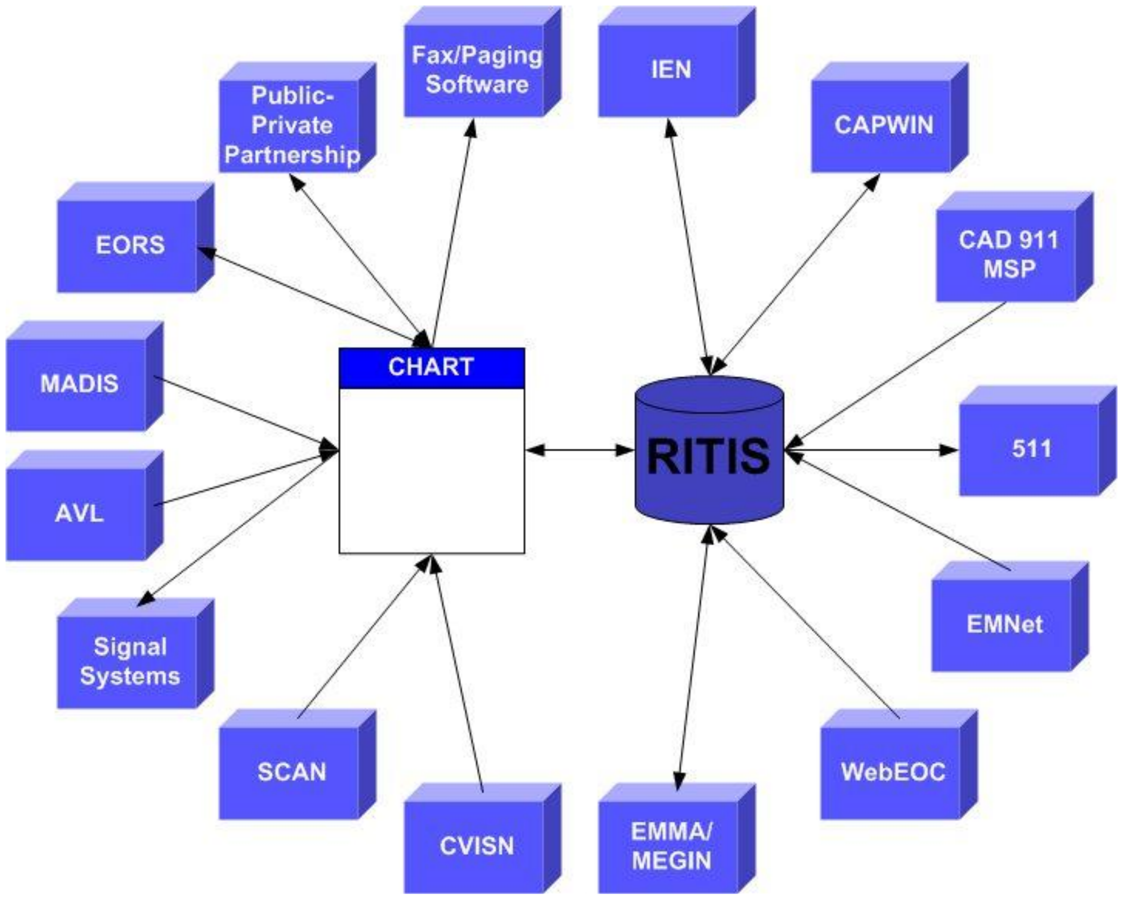


Figure 8.2.2-1 CHART System Interfaces

The external systems and comments about how they support CHART are listed in the table that follows.

Figure 8.2.2-2 CHART System Interface Descriptions

Application/ Organization	Description	Comments
511	Phone-based traveler information.	These systems distribute incident travel time, weather, construction, etc. provided by CHART.
AVL	A contracted provider of Automated Vehicle Location data services.	Typically, implementing AVL means contracting with a company that has the necessary satellite communication infrastructure to make AVL possible. They deliver the data in user-specified form or in their own map-based display application. Currently there is an ongoing pilot project for maintenance vehicle tracking.
CAD 911 MSP	Computer-Assisted Dispatch systems; Maryland State Police 911 systems.	These systems can provide incident data to CHART. MSP does not have an integrated CAD system; they use separate applications at each barrack (approx.

Application/ Organization	Description	Comments
		30). At least 3 barracks currently have the same radio consoles as CHART and MEMA. Possibly in the short term CHART could link to their radios on a regional basis.
CAPWIN	Capital Wireless Integrated Network. CapWIN is a wireless integrated mobile data communications network being implemented to support federal, state, and local law enforcement, fire and emergency medical services (EMS), transportation, and other public safety agencies primarily in the Washington, DC Metropolitan area.	The purpose of CapWIN is to enhance regional communication and messaging systems, to effectively create a multi-state, inter-jurisdictional transportation and public safety integrated wireless network. CapWIN provides a "communication bridge" allowing mobile access to multiple criminal justice, transportation, and hazardous material data sources Currently the data available via CAPWIN is too law enforcement-based for most CHART purposes. Includes user-friendly chat room and directory of names.
CVISN	Commercial Vehicle Information Systems Network. Information network that provides information about permits for vehicles such as vehicles with wide loads.	CHART only uses a very small percentage of the information provided via CVISN. CHART may provide incident information to CVISN in the future, and would like to get information for alerts and possibly travel times between weigh stations.
EMMA/MEGIN	Emergency Management Mapping Application/ Maryland Emergency Geographic Information Network. EMMA is a secure, web-based mapping application that enables the emergency management community to display relevant information before, during, and after an incident occurs. Developed by the Towson University Center for Geographic Information Sciences (CGIS)	EMMA enables the emergency responders to identify incident locations from the field, generate location-specific reports, visualize incident locations via a map, perform site-specific spatial analysis, and coordinate response efforts. MEGIN is the corresponding metadata repository for EMMA-generated data. In the future, CHART will share data with EMMA through the RITIS interface.
EMNet	Maryland State Police Emergency Management Network. EMnet is a privately managed messaging network for the Emergency Management community. The system was originally developed to be the digital replacement for the National Warning System (NAWAS), linking the President with state and municipal governments.	EMnet allows for direct-to-broadcaster transmission, forwarding of pictures, attachments, reports and other data, confirmation that the message was delivered to specific radio stations, and confirmation that the party in question broadcast the EAS message. It is used occasionally by CHART operators to verify major law enforcement-related events before taking action (e.g., Amber Alerts). Every CHART TOC has an EMNet workstation. Future integration could include EMNet event alert.
EORS	Emergency Operations Reporting System. Used to manage planned road closures and work zones. It facilitates winter operations.	EORS is a separate application that is not yet integrated into CHART. Some EORS data is displayed on the CHART website. Would like to have shop status and open/closed TOCs to be added to CHART map, weather-related lane closure data, state-wide snow emergency plans, pre-event plans (e.g., for funerals),

Application/ Organization	Description	Comments
		the SHADE (SHA Data Encyclopedia) phone directory features, Statewide EOC plans and other pre-event planning for the shop (e.g., "At midnight we're bringing in x resources).
Fax/Paging Software	3rd party software that automatically issues pages and faxes to specified response personnel in response to data entered by operators or error conditions reported by network management systems.	The current paging system is a separate application and cannot support integration with CHART. An appropriate system that will support integration must be identified for future use.
IEN (TRANSCOM)	Information Exchange Network. TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York - New Jersey - Connecticut metropolitan region. It was created in 1986 to provide a cooperative, coordinated approach to regional transportation management. Its major public outlet is the TRIPS 123 website.	During major incidents, construction, and special events, TRANSCOM helps to marshal regional resources for incident response. These resources include its member agencies' variable message signs and highway advisory radio, which get the word out to travelers. Sharing these resources allows information to reach a much wider public. TRANSCOM also provides these services under contract to the I-95 Corridor Coalition, as the Coalition's interim communications center. The I-95 Corridor Coalition includes the major transportation agencies in the Northeast, from Virginia to Maine. Like TRANSCOM, the Coalition seeks to link transportation providers across political and geographic boundaries. Several of TRANSCOM's members are also members of the I-95 Corridor Coalition. Integration/data sharing with TRIPS-123 would provide additional notification and insight into major events in the greater New York regions that could impact traffic along the I-95/US-1 corridor as far south as Maryland and vice versa.
MADIS	Meteorological Assimilation Data Ingest System. MADIS is a COTS weather forecasting product.	MADIS is dedicated to making value-added data available from NOAA's Earth System Research Laboratory (ESRL) data to improve weather forecasting. May be used to supplement current CHART weather station data and/or future weather-related data from RITIS.
Public-Private Partnerships	3rd party provider of data and/or devices to CHART	These partners could provide speed data and/or travel times through cell phone tracking or AVL, service-based speed data, or devices maintained by a 3rd party.
RITIS	Regional Integrated Transportation Information System. RITIS is the tool developed by the University of Maryland to aggregate regional traffic-related information. Includes VDOT, MDOT, DcDOT, WMATA data, WebEOC, CAD 911, 511, CAPWIN, MCTMC, etc.	RITIS is envisioned as primary conduit for distributing other key data and emergency related data such as from EMMA/MEGIN, WebEOC, etc. Key issue: Current funding is for development, but the funding for on-going operations is uncertain. Currently CHART provides its data to RITIS and receives event data from RITIS.
SCAN	COTS subscription service for	CHART would like to be able to provide alerts based on

Application/ Organization	Description	Comments
	weather information used by CHART. It collects weather and roadway sensor conditions data.	weather (fog, wind, snow, etc.), capture the weather conditions when an incident is created, and possibly add a weather layer to the CHART map.
Signal Systems	SHA signal shop systems. Responsible for the programming, operation, and maintenance of traffic signals controlled by SHA.	The signal management systems are not currently integrated with CHART, but CHART needs more visibility into these systems and possibly the capability to control signal timing. Key: there would need to be either built-in and/or on-site expertise to manage this. Examples of data requirements include: signal health and status, video from autoscopes, speed/volume/occupancy, shop/personnel status (e.g., deployed to fix signal)
WebEOC	WebEOC is MEMA's incident management COTS product for managing emergency operations and response.	WebEOC is the product of choice in Maryland for emergency operations management. A statewide license allows use of the product by counties and cities. Not all Maryland counties use WebEOC. During emergencies CHART operators must copy/paste incident data into WebEOC. In the future there may be an automated data push interface. WebEOC also has a chat room capability.

As suggested by many of the table entries above, one of the most significant interfaces to be enhanced is with RITIS, for this is envisioned to be the primary conduit for distributing other key data and emergency related data such as from EMMA/MEGIN. WebEOC, etc. A conceptual view of how this interface would function to capture and coordinate the distribution of data is shown in the graphic below.

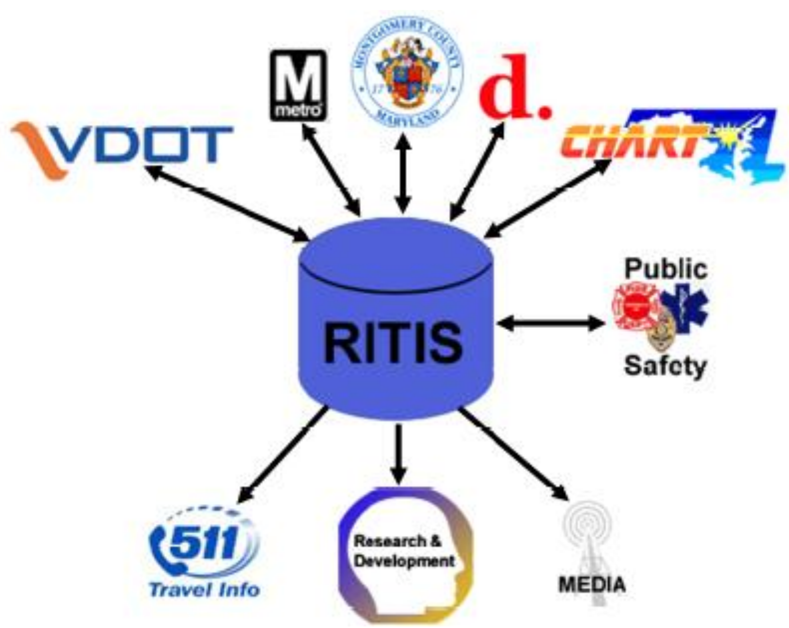


Figure 8.2.2-3 Conceptual View of Regional Traffic Management Data Interfaces

8.3 Application Approach

The Application Approach addresses the future of the CHART application in terms of::

- Enhanced Application Approach – the features and capabilities that can be added to the application itself to enhance operator productivity (Section 8.3.1).
- Application Architecture Approach – the physical arrangement and connectivity between the components of CHART and the external systems with which it interfaces (Section 8.3.2).

Each of these approaches is described in more detail in the subsections that follow.

8.3.1 Enhanced Application Approach

For CHART to fully evolve as an organization, it must improve the software applications that support its business processes, and provide timely, accurate, and easily accessible data for operators to do their jobs more effectively. The improvements that were identified in the workshops can be categorized as needs for: greater usability, more automation, more intelligence, and increased integration, as noted above in the Application Vision section (8.1.1). As shown in the figure below, as CHART takes these increasingly more challenging steps toward improvement, it will arrive at the top where its users and operators will function as traffic managers and be more confident and satisfied with their tools.

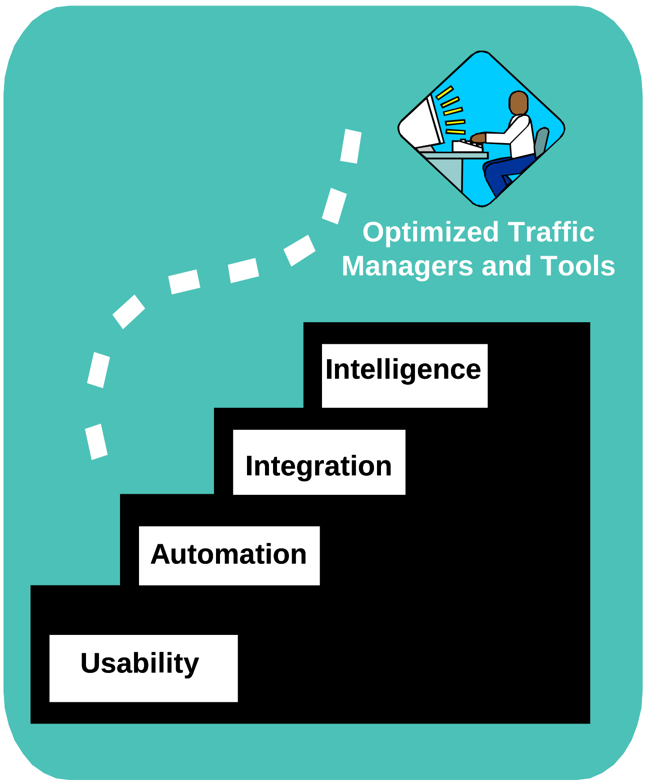


Figure 8.3.1-1 - Steps to Improve CHART Application

Throughout the workshops, enhancements to the CHART application were discussed. The subsections below describe, at a summary level, the enhancements in terms of the usability, automation, integration, and intelligence steps.

8.3.1.1 Usability

Having a system that is easy to use is as important as having increased functionality. Enhanced usability can increase operator efficiency and effectiveness.

During the workshops, CHART operators identified several ways in which the CHART system could become more usable. Some examples of usability enhancements are listed below. See Appendix B for more:

- A reduction in the number of menus and links that appear on the home screen.
- For location pull downs, have a separate short list of common locations that are well known (e.g., Bay Bridge, Woodrow Wilson bridge).
- Provide audible alerts on instant messages.
- Judicious use of pop-ups; e.g., vehicle information for an event should not be a pop-up.

In addition to some of the specific usability enhancements noted above, the workshop participants created a notional view of an improved screen layout. Specific suggested alternative home page will be defined during later requirements and design phases. With this new model, there will generally be two windows open: a home page (a mockup of which is shown in the figure below) that provides the operator with the big picture, plus a second window where operator-specific tasks like editing a traffic event are completed.

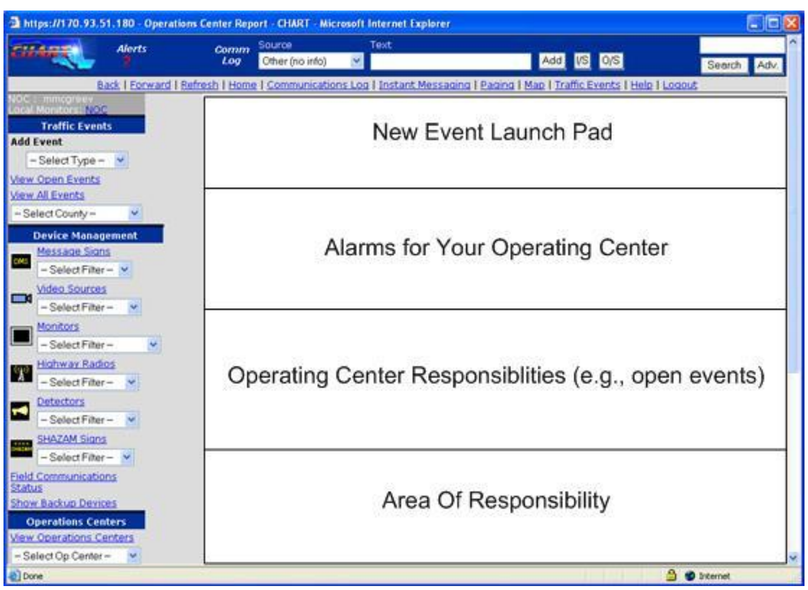


Figure 8.3.1.1-1 Specific Alternative Home Page

The working area of the home page could be separated into four main sections:

- The first section provides a launching pad for opening a new event. When the operator selects to open an event, a new window could be launched, or an existing open window could be used. This is where the new event information could be entered. When the operator is finished, the second window can be closed and the operator is returned to the home page.
- An area below the New Event Launch Pad could provide alarms relevant to the operator, with an option to see all alarms. Alarms include reminders set up in the system, plus any alerts relevant to the operator.
- Below the Alarms area is an area that shows the open traffic events for which the user's operating center is responsible.
- The area of responsibility section at the bottom of the new home page could include open events within the operator's area of responsibility, which could include events opened at other operating centers (e.g., for the AOC, this would include TOC4, AOC, and SOC open events).

Additional changes requested for the home page include adding recently viewed cameras, having the left frame itself only display when the operator chooses to display it (by moving the mouse to the far left side of the of the home page), and only showing the open events in the list of recently viewed traffic events.

The factors mentioned above along with the notional screen design contribute to making the CHART system more usable.

8.3.1.2 Automation

CHART users expressed an interest in having the software automatically perform certain functions to ease their burden of manually performing routine tasks. Some examples of automation that could help CHART users are listed below. See Appendix B for more:

- Schedule repeating events and alert the user at the scheduled time (e.g., enter an entire season of Raven's home game events with pre-defined device activation start/stop times).
- Provide alerts for events that have remained open for too long.
- Prompt the user to create a CHART event with lane closures upon roadwork activation in EORS.
- Track the age of the data stored in the system. (This would allow users/operators to know which information is current).

Some of the key benefits of automation are described below.

Enhanced automation also increases productivity. Ideally, the CHART system would perform nearly all of an operator's routine and/or tedious tasks. Currently, for example, CHART users manually update maps with the locations of events. However with automation, the software would not only provide auto-mapping, but also would allow for automatically programmable HARs and DMSs, automatic weather alerts, automatic paging, and automated incoming data collection. With this capability, operators would never have to manually enter in times – sensors could automatically update travel times on the DMSs.

Increased automation contributes to safer roads. The CHART system could be used to automatically and accurately provide information concerning road closures. It could contain a scheduler that would e-mail scheduled lane closures to EMS responders daily, and provide automatic planned road closure time based on when the road was scheduled to reopen. Also following a road closure (once the scene is clear), CHART could automatically show the lanes reopened and deactivate signs (the signs are currently automatically deactivated upon closure of the event).

8.3.1.3 Integration

The ability to effectively interface with the personnel and systems managed by external organizations on a daily basis may be facilitated by increased information exchange via more tightly integrated respective software applications. There are two types of integration:

- **Internal**: Seamless more usable CHART system (e.g., integration of the CHART map and reporting functions).
- **External**: Increased ability to leverage the data from other external systems. As noted above, the CHART application functionality and utility is enhanced and broadened by accepting additional data from and providing additional data to numerous related external systems.

Some examples of improved internal and external integration are listed below. See Appendix B for more.

Figure 8.3.1.1-3 – Examples of Improved Internal and External Integration

Internal Integration	External Integration
Automatic mapping of CHART events.	Integrating EORS features to provide two-way data sharing on construction-and weather-related events (e.g., permit tracking, point-of-contact info, potential event conflict).
Integrating CHART's cameras with those of other agencies.	Increased data exchange with RITIS to facilitate CAD 911 capabilities and access to non-Maryland regional traffic events.
Integrating future AVL systems to display on a single map in CHART.	Automatically create an Amber Alert event in CHART from EMNet, putting all signs in suggested formatted messages.

8.3.1.4 Intelligence

Participants in the workshops expressed the desire for increased "intelligence" and decision support in the CHART software to help them make better, faster decisions. Decision support is the software's built-in intelligence that enables users to more easily make important decisions that impact their work. Decision support makes these decisions easier by providing additional information, recommendations or reminders to the users. Some examples of decision support requirements are listed below.

- Provide default messages for DMSs based on event type, event location, and DMS configuration (e.g., number of lines of text).
- Identify recommended FITMs or alternate routes based on event type and location.
- Suggest appropriate notifications and requests for resources based on event type and location (area of responsibility).

More examples are described in detail in Section 4.3.2 (process 2.1) and Section 4.3.4 (process 4.1.2.2); and are listed in Appendix B.

Some of the key benefits of decision support are described below.

Decision support can lead to greater efficiency. As decision support is added to support the CHART operation, users of the CHART system can become more efficient in their ability to retrieve pertinent information to respond to events. With the aid of decision support, operators can become not only faster but also more accurate in managing events and traffic. Decision support can also reduce confusion among operators by eliminating duplicate events and helping with the selection and allocation of resources needed to respond to an incident.

Decision support empowers operators to become Traffic Managers. As the users/operators are able to use more decision support capabilities, they will increase their ability to manage traffic as opposed to simply responding to events. CHART operators and managers expressed a desire for the operators to be more empowered so they can assist the traveling public more effectively. For instance, decision support could allow operators to know what resources are available by providing a layer on the map that shows which shops are open. This could give the operator a greater appreciation for the time it will take for the resources to be deployed and reach the scene.

Having valid data greatly improves decision support and intelligence. Since having valid data is vital to users of the CHART system, the CHART software developers need to add more data validation functions to identify and/or eliminate erroneous data, and prevent invalid data from being entered into the system. CHART should be designed to make specific fields mandatory, provide more error-checking, provide more pull-down menus and fewer free entry text fields, and/or provide "smart" ways for the system to fill in data (e.g., automatically mapping an event to get correct latitude and longitude, adding date/timestamps for event activities instead of having an operator record it or comparing probe-based speed data to speed sensor data to verify accuracy). This is addressed in more detail in the Data Model section 7.2.4.1, and 7.2.5.

8.3.2 Application Architecture Approach

While the current application architecture meets most of CHART's needs, there are opportunities to enhance the speed, reliability, data access and distribution of CHART-related data through an expanded architecture that leverages new protocols and technology. J2EE has emerged as the leading industry-standard integration architecture for network applications like CHART. Appendix D presents a possible phased migration of the CHART baseline architecture that reflects a systematic approach to incorporate system enhancements as the system is transitioned from its current CORBA implementation to a J2EE architecture. Should this approach be adopted, the benefits of J2EE migration could mitigate long-term maintainability, supportability, and expandability concerns for CHART. This approach also minimizes the risk of service disruption when compared to a "big-bang" replacement of the existing CHART components.

8.4 Application Recommendations

To continue to improve CHART's performance and fulfillment of its goals and objectives, several specific suggestions were documented during the workshops. They have been summarized in the sections above, and categorized as mid-level requirements (not so high level as to be too generic, but not so specific as to constitute system requirements). Approximately 28 mid-level requirements related to application changes were identified (listed below). Each of these was evaluated as part of the Release Strategy activities that are more fully described in Section 10. Note: No priority is intended by the order of the list below.

- Integrate/improve lane configuration data entry in an event definition (not map or map data)
- Implement CHART user interface improvements as desired by CHART management/user community (possibly done in concurrence with event flow processes #21)
- Improve text-to-speech capabilities
- Integrate/automate with paging/faxing system
- Enhance communications log; filters on event comm log
- Add capability to automatically generate reminders associated with the scheduler
- Integrate with RITIS – RITIS, when mature, may serve as a single interface to the following systems: Regional 911, IEN, CAPWIN, EMMA/MEGIN, WebEOC, 511
- Improve map data granularity: cross streets, bridges, emergency response facilities, etc.
- Integrate CHART map and provide single map interface
- Integrate SCAN
- Integrate with other local and regional CCTV systems
- Integrate with MCTMC CCTV system
- Improve map lane configuration data; check for latest data, other data sets, etc.
- Data exchange with EMMA/MEGIN

- Integrate with Signal shop systems
- Include SOPs into CHART user application
- EORS integration phase 2 – all remaining functions
- EORS integration phase 1 - event management
- Integrate EMNet
- Integrate/improve reversible lane control systems
- Integrate with CVISN -- maybe OBE; to be checked
- Integrate with internet video;possibly provide link; investigate feasibility
- Integrate with WebEOC
- Integrate IEN/TRANSCOM data
- Integrate with regional 511 systems
- Integrate with regional 911/CAD systems
- Integrate with other MDOT CCTV systems
- Integrate CAPWIN chat/paging data

9 Technology Model

The Technology Model section discusses three major aspects of Technology as it relates to CHART. These include:

- CHART's technology direction including the vision and guiding principles, constraints and assumptions (Section 9.1).
- The CHART technology context; the infrastructure that supports the technology (Section 9.2).
- Current and future technologies and their applicability for CHART (Section 9.3)

The Technology Recommendations to address all of the above are provided in Section 9.4).

Technology is at the heart of the CHART organization. CHART heavily relies on technology to accomplish its mission and it is the State of Maryland's primary organization for the Intelligent Transportation System (ITS) standards. CHART adheres to state and federal ITS standards and is guided by its own technology principles. The applicable national and statewide ITS standards are outlined in Appendix E.

9.1 Technology Direction

The Technology Direction outlines the CHART vision for the expansion of current technologies and the use of new technologies. It also outlines the principles, constraints, and assumptions that guide the selection and implementation of future CHART technologies.

9.1.1 Technology Vision

The key vision statement for the vision for the future CHART technology, as described by the workshop participants is:

More devices, smarter devices, field-accessible devices.

Elements of this vision are addressed in the Technology Recommendations section 9.4. Specific examples of this are outlined below:

- Information from CHART devices and sensors, and vehicles themselves will support automated incident detection and congestion detection, and will provide information to the public (e.g., via HAR, DMS and other) and to operators in order to divert traffic to less congested roadways.
- To improve field operations capabilities and reduce response time, CHART will:

  - Have sensor and camera coverage across the entire state highway system.
  - Provide data and video to AND from field responders and management as appropriate. Examples:
    - Provide field access (e.g., portable units) to CHART (e.g., for events, disabled vehicles, etc.) and agency resources (e.g., e-mail).
    - Provide stationary but movable in/on-vehicle cameras (e.g., dash cameras mounted on the trucks that could even automatically take a snapshot when the arrow-board goes up)
    - Provide detachable/mobile cameras and/or video equipment that are capable of transmitting images directly into CHART.
- Provide better access to aerial assets to monitor traffic and relay/enter information (via on-board CHART).

9.1.2 Technology Principles

CHART's technology principles are:

- CHART will use/employ technology that promotes flexibility, expandability, and is open and scalable
- CHART will ensure that our hardware (e.g., devices) and software are compatible. CHART will coordinate the evaluation and purchase of technology to ensure compatibility.
- CHART will update its technology as needed and on time.
- CHART will use statewide communications assets (such as the MDOT Network and microwave system) to meet the bulk of its wide area network requirements.
- Existing technical components will be incorporated (as deemed appropriate) to support future business requirements.
- CHART will be fully distributed.

9.1.3 Technology Constraints

Though CHART will make every effort to adhere to the ITS standards and follow its own guiding principles, other factors inhibit CHART's ability to reach its goals. Some of these factors are:

- Technology evaluation, selection, and implementation must be coordinated with MD wide area network specialists.
- The MDOT network access rules support desired capabilities.
- All technology must conform to all appropriate national ITS standards
- CHART must use existing field devices.

9.1.4 Technology Assumptions

The CHART organization makes assumptions in order to proceed with its technology strategy. These strategies can adversely impact CHART's desire to reach its goals if the assumptions prove to be false.

- The number of operations centers and devices will continue to grow.

- The MDOT Backbone Network will continue to be managed by MDOT and support CHART's use where applicable.

9.2 CHART Technology Context

The following diagram shows the current technologies used by CHART and how they interface with the CHART application components (see Section 8.2) via the Maryland Department of Transportation (MDOT) network.

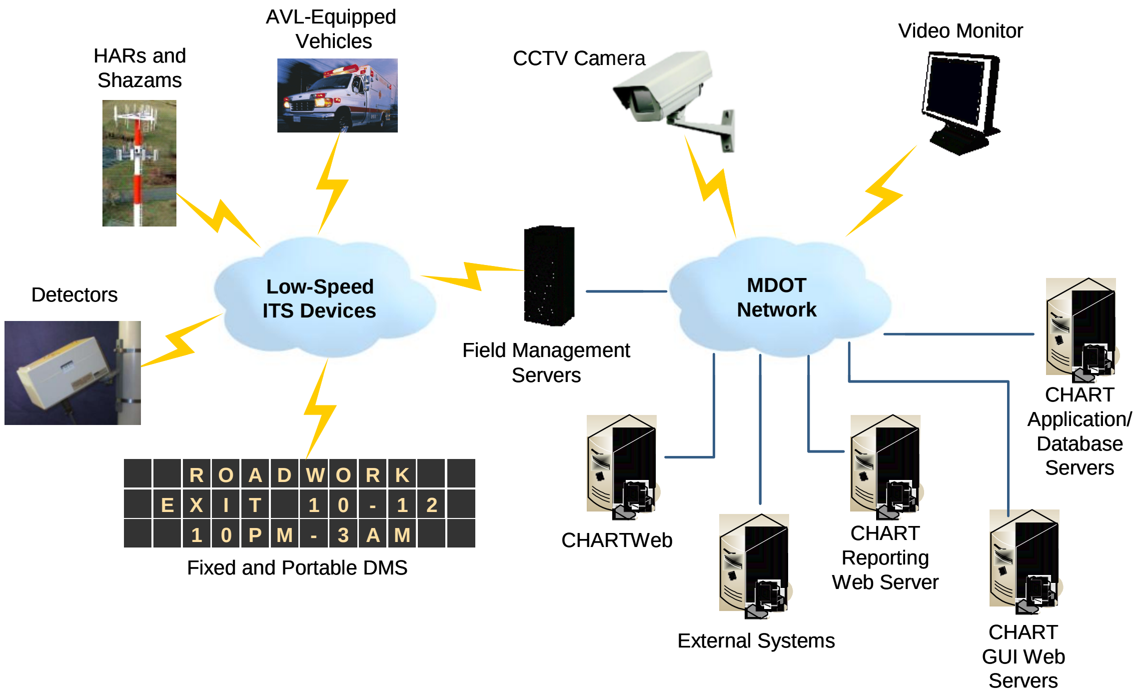


Figure 9.2-1 CHART Technologies and Interfaces via the MDOT Network

9.3 Current and Future CHART Technologies

CHART has been using technology effectively to capture, analyze, and disseminate data to manage events and provide information to the traveling public. However, new advances in ITS make more capabilities within reach of CHART, and enhance the ability to proactively manage traffic and more efficiently respond to events. The current and future CHART technologies are shown on the figure that follows. The figure shows the current CHART technology on the left and the future/planned CHART technology on the right. Each of the current technologies and future technologies (and their uses, advantages, and disadvantages) is described in more detail in the following subsections. *Note: Other technologies considered but not currently planned include: bio-hazard/radiological detection, ramp metering, and variable speed limit systems.*

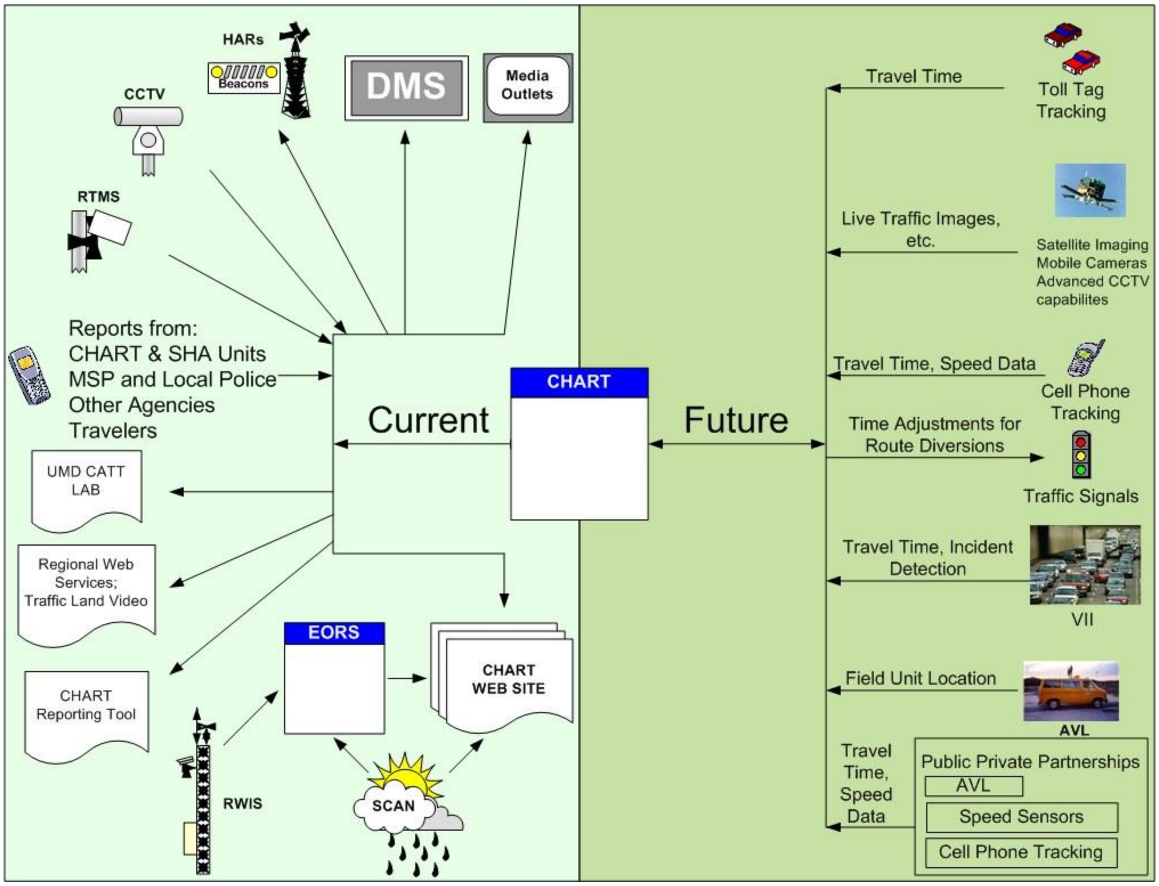
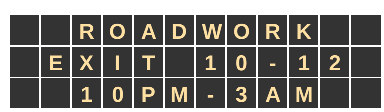


Figure 9.3-1 Current and Future CHART Technology

Each of the current technologies and future technologies (and their potential uses, advantages and disadvantages) is described in more detail in the following subsections.

9.3.1 Dynamic Message Signs (DMSs)



Dynamic message signs are programmable displays for disseminating information to the traveling public, principally motorists. Erected along major highways and arterials, operators send messages to the DMSs to warn motorists of travel conditions in their vicinity. The DMSs are also used for public service announcements such as Amber alerts and Homeland Security threat advisories. CHART currently has approximately 311 installed DMSs, including both fixed and portable signs. This is a mature technology but advances have been made in the portability and ability to configure the devices.

Advantages/Uses: DMSs are very effective and moderately reliable in providing information to the traveling public in-transit. Newer DMSs integrated into CHART use NTCIP-compliant protocols. The advent of NTCIP-compliant DMSs promises to minimize the need to customize CHART to support new DMS models. Newer models also have the ability to display multiple messages, and correspondingly, message arbitration and queuing capabilities are continuing to evolve in CHART. Portable DMSs are especially useful in managing incidents and recurring construction events, as they can be moved around from site to site on an as-needed basis.

Disadvantages/Challenges: DMSs are relatively expensive, but SHA believes in them, so the challenge is how aggressively CHART continues to grow the DMS network. There are some public trust issues with respect to DMS message content and accuracy, but increased data quality and better information (e.g., travel times) have the potential for making these devices more useful and trusted by the traveling public. One current challenge is that the CHART operators don't always know the operational status of the devices (whether the message is really being displayed, if the device is out of service for maintenance). This is being addressed by planned integration of the device status web page into the CHART application.

Communications to the portable DMSs relies on cellular technology. Each portable has an embedded cellular modem. To control costs, they are polled less frequently than the other DMSs, so their operational status is not as accurately reported. Also, calls to the portables are subject to the inconsistencies of celluar service, eg. dropped calls, weak signals, etc.

9.3.2 Highway Advisory Radio (HARs) and SHAZAMs

Highway Advisory Radios are low-powered radio transmitters that are used to broadcast pre-recorded messages to travelers. SHA HARs broadcast on a range of AM frequencies. The specific broadcast frequency for each HAR is posted on roadway signs in the vicinity of the HAR. Many of these signs have flashing beacons that can be activated when critical traveler information is being broadcast. The HAR sign with beacons is called a SHAZAM by SHA. As with DMSs, HARs and SHAZAMs are mature technologies. The CHART HARs use proven analog technology. Newer HARs are currently being integrated into CHART that and provide the ability to synchronize a message across several HARs. This will allow travelers to pass through a region and hear a message seamlessly as they pass from one HAR to another, even where the broadcast range overlaps.

Advantages/Uses: CHART currently has approximately 51 installed HARs and 33 SHAZAMs. They are moderately effective and very reliable in providing information to the traveling public.

Disadvantages/Challenges: HARs broadcast to a limited region, and given the corresponding geographic profile, reception by motorists may be limited. As indicated by the numbers above, there are more HARs than there are SHAZAMs. The HARs that do not have an associated SHAZAM are likely to be less utilized since there is no way to alert travelers that important information is available. Also, in some cases, there is no sign indicating that a HAR is broadcasting in a given area (missing signs). This could be remedied relatively easily and cheaply and could quickly improve the impact and utility of existing technology. In other cases, the signs are not correctly placed relative to the area covered by the broadcast (e.g., by the time you see the sign, the broadcast signal is too weak to hear the message). Another challenge is that the CHART operators have difficulty knowing which way the SHAZAM is facing and could erroneously be alerting the public to irrelevant traffic issues (e.g., accident in the opposite direction

Due to the older analog communication technology used for the HARs/SHAZAMs, they are the least reliable devices in the network. The analog HARs do not have the capability to return an acknowledgement that a command sent to it was actually executed. To verify a message is being played, operators have to call the HAR and listen to the message on the monitoring line.

Future digital technology enhancements for HARs are available for integration, but would require a costly investment on the part of SHA. NTCIP-compliant HARS are also under development, but this technology is still immature.

9.3.3 Toll Tag Tracking Technology (FUTURE)

Toll tags are electronic toll collection systems that help to quickly and efficiently move traffic through toll facilities. A motorist with a toll tag transponder mounted on the inside of the windshield or on the license plate, can travel through toll lanes without stopping and the toll is automatically deducted from a pre-paid account. These transponders can be tracked and aggregated, which can help traffic managers accurately determine traffic speeds and to a lesser degree, traffic volumes between toll tag readers. Currently CHART has plans to work with MdTA to develop conceptual requirements for using toll tag technology in the future.

Advantages/Uses
Toll roads (and HOT lanes that also use this technology) are becoming more common and thus there are more opportunities to track and monitor cars using the transponders. These devices provide accurate travel time data and technology is available that compensates for changes in speeds when drivers exit and reenter the toll roads. It only takes 2-3% of the traveling population using this technology for this to be sufficiently accurate and viable.

Disadvantages/Challenges
The toll tag technology is strictly limited to toll roads or areas that have data collection stations to capture the data from the toll tag transponders. Effective use of the technology will require the erection of data collection stations between the toll collection facilities.

Traffic at toll booths is not representative of actual traffic flow, so accurate speed and volume data has to be collected at points in between the toll plazas.

While it is important to monitor traffic and speeds on major roadways, at present this technology is deployed only on major routes. It is essential to have many data collection points in order to effectively monitor traffic using toll tag technology; however, in CHART's current build schedule there are no plans for CHART to put more detectors on the roads. Public perception of security and privacy issues is also a drawback.

9.3.4 Cell Phone Tracking (Future)

Cell phones transmit signals back and forth between the phones and the cellular towers. These signals can be monitored to determine the position of the cell phone at a point in time, which enables traffic managers to determine the speed at which the device is traveling. As a result, cellular technology can be used to monitor traffic speeds and estimate travel times. Baltimore City is currently conducting a pilot program to evaluate the effectiveness of using cell phones as probes.

Advantages/Uses

This technology can be used wherever the cell phone goes as long as it can communicate with the cellular transmission towers. It can be used on arterials as well as freeways and major roads; wherever the current infrastructure is already in place. Under normal traffic conditions, the cell phone tracking technology can provide an accurate measure of traffic speeds and travel times, especially in well-trafficked areas such as the I-95 corridor. This can be useful in incident situations to increase the accuracy of calculating queue length since there's an increased usage of cell phones in heavy backups. This technology can also be cheaper per mile than point detection since there are no installation and maintenance costs; only the costs of the service that is purchased to capture and process the data.

Disadvantages/Challenges

Although the cell phone technology can accurately measure speeds and travel times during normal traffic, some cell phone tracking technology has been shown to be highly inaccurate during dramatic changes in speed. This is due to lengthy sample time (the time between measurements of the position of the cell phone) in the devices used by some cell phone tracking companies. In order to use the cell phone tracking, the cell phone must actually be in use, not just powered on, to be measured. Also, the quantity of data can be significantly limited in rural areas and in the evenings when traffic flow is low. Several vendors offer services using various methods of capturing and processing cell phone data. In addition to the drawbacks of the technology itself, there are privacy concerns. CHART is considering how best to address these issues and evaluate these services.

9.3.5 Traffic Signals (Future)

Traffic signal management can be used to facilitate improved traffic flow on arterials. Traffic signal timing adjustments can be implemented to improve traffic conditions in response to a traffic incident or event, or to relieve recurring congestion. Some of these systems supplement manual timing adjustments with various methods of automation. The manner, method and protocol used to implement the traffic signal timing can vary depending on the underlying technology; some use fuzzy logic, artificial intelligence, or queuing theory. SHA has fielded advanced signal controllers that can be used to control multiple grids of signals. These could be used to implement a "traffic plan" when a traffic incident occurs. For the most part, they are currently fielded as "closed loop" systems, meaning that each signal grid operates "autonomously". Typically, one signal controller in the grid is designated the master, and it coordinates the operation of all of the other controller units. There is little communication between the closed loop grids and the Signal Shop. Communications to the controllers is via dial-up modem connections. Signal engineers and technicians periodically call the controllers to assess system health and make configuration and timing adjustments.

Advantages/Uses

These advanced techniques can be used to optimize the management of overflow traffic onto arterials during incidents or heavy congestion on the highways. It can assist managing the diversion of traffic onto arterials when a FITM has to be implemented. Empirical data has shown that traffic signal timing works more than ***twice*** as fast as law enforcement directing traffic. This traffic signal technology can influence both the direction and the time that motorists take when traveling on certain roadways

Disadvantages/Challenges

The major problem with signal control is integration. Although SHA controls a significant number of signals state-wide, the physical integration of traffic management would be challenging, and can vary at the local level. First, to effectively integrate signals into CHART would require an overhaul of communications to the signal controllers. Something more robust and responsive than the current dial-up system would likely be necessary to support much more frequent communications to the signals. Second, there are regional and local level integration issues with non-SHA signal systems. There are corridors where SHA and locally controlled signals are intermingled.

For example, in a string of traffic signals, such as those leading to the Hatem Bridge, there may be one or two locally controlled traffic signals in the middle of 10 SHA signals. Local government/agency cooperation is a necessity to implement signal control on a statewide basis.

The current signal management system still requires frequent on-scene adjustments, and it is difficult to get the "big picture" of traffic flow in a specific area. Signal management is currently the responsibility of the Signal Shop. Increased cooperation and coordination with CHART activities and the signal management personnel and systems are necessary. In the future, CHART needs visibility into these systems and activities to effectively manage traffic and respond to incidents; and perhaps integration of some functions.

9.3.6 Closed Circuit Television (CCTV)

CCTV is an especially important tool to CHART operators in monitoring roadways and incident-related activity. They can see the situation real-time, determine the exact location and direction of the incident, determine the lane configuration/closure statuses, note the arrival and departure of responders, estimate queue length, etc. It is also useful in monitoring traffic, evaluating traffic flow, and detecting incidents. Because this technology is so effective, CHART would like to be able to have access to more camera images to monitor more roadways, including more than just the current major highways.

Advantages/Uses
Cameras are relatively inexpensive to deploy, and recent technology advances make it even more attractive; more refined tilt, pan, zoom capabilities; calibrated block out (e.g., not allowing views of non-roadway images), night vision adjustments, windshield wipers, disabled vehicle detection). Newer models, particularly digital cameras, may be able to leverage existing communications and wireless networks more effectively by being easier to integrate into CHART.

CHART currently supports the use of MPEG-4 video compression, a standard for low bandwidth video compression. This enables CHART to get increased coverage at lower costs than other jurisdictions. CHART relies on relatively low-cost T1 communications to camera sites, which has enabled the deployment of CCTV in areas where SHA does not have access to fiber optic cabling. CHART is also considering installing cameras in non-traditional locations such as on response vehicles (the devices could be automatically triggered to feed video, but could also be driver-configurable), and possibly subscribing to a satellite imaging service that could provide valuable aerial information for analysis of incident activity, assessing queues, etc.

Disadvantages/Challenges
Even though this is a cost-effective technology, it still requires capital investment, which CHART intends to minimize over the long term. To offset this, CHART is considering leveraging third-party and other regional relationships (e.g., Prince George’s County, Montgomery County, etc) to gain access to those organizations’ video feeds. There are security and privacy issues with camera use, and data ownership issues with respect to using and potentially distributing third party camera images in CHART.

9.3.7 Point Detection (Future)

Point detection refers to fixed-location devices that are programmed to detect specific conditions. CHART uses many types of point detection devices to monitor traffic flow (e.g., speed detectors, snapshot cameras), roadway conditions (temperature, ice), environmental conditions (wind, fog), etc.

Advantages/Uses
Point detection technology is fairly mature, and these devices provide very accurate information when they work. Many of the installed devices have multiple purposes, some of which are not currently enabled, and/or CHART has not yet been programmed to accept or process the data. CHART is not currently planning to invest in significant numbers of new point detection devices, but to increase current coverage by expanding current capabilities (e.g., use more features from the detectors the have, and increase use of non-fixed detection devices such as probes), and by leveraging data from other sources such as third parties.

Disadvantages/Challenges
These devices require maintenance and CHART has experienced many maintenance troubles with them. Also, in order to capture the data along various roadways, many detectors need to be in place, which can be expensive. Currently CHART has no plans to purchase more of these devices but would consider leveraging the technology should another organization choose to purchase them.

9.3.8 Vehicle Tracking (Automatic Vehicle Location - AVL) (Future)

AVL uses Global Positioning System (GPS) technology to locate and track vehicles to a specific geographical location. DBM is currently conducting a pilot program to evaluate the effectiveness of using AVL. Additionally, Baltimore City is conducting a pilot program to evaluate the effectiveness of AVL using fleet vehicles. MTA also has AVL in its busses. CHART also started a pilot AVL program and has AVL on some of its vehicles.

Advantages/Uses
This technology can be used on all types of roadways and is very accurate (sometimes within 10 feet of the device). Not only can it locate vehicles, it can calculate the speed of traffic flow by knowing a vehicle's physical location at two different points in time (useful for calculating vehicle response time, queue length, etc.). CHART could use AVL to better track the location, availability and proximity of emergency response vehicles to an area that needs emergency services. AVL has a relatively low infrastructure cost since it is a small device that is installed on the vehicle.

Disadvantages/Challenges
The vehicles that are the most likely to be AVL-equipped (police cars, buses, maintenance trucks, snow plows, etc.) do not typically follow the normal flow of traffic. AVL's focus is knowing where vehicles and resources are currently located. Therefore, the opportunities to effectively use AVL for collecting traffic data are limited. It would be better to enter an agreement that allows access to fleet data from trucking and intercity bus companies to obtain AVL data that represents actual traffic flow. Another disadvantage is that the on-vehicle devices are small; they can be subject to tampering.

9.3.9 Vehicle Infrastructure Integration (VII) (Future)

This technology emerged as a product of an initiative spearheaded by the U.S. Department of Transportation. The central goal is to reduce the number of vehicle related deaths that occur as a result of vehicles leaving the roadway or crashing at an intersection. VII does this by creating intelligent communication (integration) between the vehicles and the roadways and traffic signals (infrastructure).

Advantages/Uses
VII facilitates vehicle-to-vehicle communication and roadway-to-vehicle communication that allows vehicles to detect or be informed of hazardous roadway conditions prior to posing a threat to the motorist. These include features such as road departure systems (that alert a motorist that he or she is heading off of the roadway), rear-end collision avoidance systems, intersection collision avoidance systems, congestion avoidance systems, and advanced automated crash notification (e.g., "mayday" systems). This technology may potentially also be used to capture travel time.

Disadvantages/Challenges
This technology is primary targeted at drivers, but could be used for CHART vehicles and has the potential for reducing the number of incidents to which CHART would need to respond. VII is not well-defined, has moderately high infrastructure costs for roadway detection devices, and will not be reliably implemented in the near future. It has the potential to generate a lot of data from all the vehicles that pass over the roadway, but this creates issues of who will use the data, and for what purpose (privacy issues).

9.3.10 **Wireless Communication (Future)**

Wireless communication is not an ITS technology per se, but can be used to support ITS as a method to communicate with vehicles and roadside devices. Many possible future systems, such as VII, mobile cameras, toll tags, and AVL are dependent on some form of wireless communication. A specific example is Dedicated Short

Range Communication (DSRC) defined to provide point-to-vehicle communication to support VII.

Wireless may also be used to augment communications when fiber optic and land line leased communications are not available. CHART currently provisions a small percentage of its CCTV camera sites using microwave communications.

Advantages/Uses
Wireless communication's greatest advantage is that it enables connectivity to locations and objects (such as a moving car) that would otherwise be impractical. Another advantage is that a wireless link can be used instead of costly leased high-bandwidth services to facilitate center-to-center communications. As discussed previously, short range wireless is the underlying component of many new ITS technologies. The in-vehicle component need to support VII is being deployed on many new vehicles already.

Disadvantages/Challenges
One disadvantage of wireless communications is that many forms require point-to-line of sight. Line-of-sight can sometimes be disrupted by adverse weather and atmospheric conditions. Other than for short range links, the opportunities to exploit wireless is limited by geography. Wireless communications based on radio technology may be subject to interference. There are also some security concerns related to interception (or eavesdropping) of the signal.

9.3.11 Integrated Parking Management (Future)

Although not strictly a separate technology, integrated parking management uses similar types of devices and data processing as for other types of traffic management – knowing where vehicles are and where they are not. This process uses processed data to calculate capacity and distribute data to the traveling (or parking) public (e.g., via DMS, HAR) to manage ingress and egress into areas of finite vehicle capacity. There is increasing demand for this service, especially for drivers of commercial vehicles (the trucking industry) who are required to limit their time on the road and need to know the capacity at the available parking areas. Other industries that are interested in these services include airports (which CHART currently supports), sporting events, concerts, mass transit stations, business districts, etc.

Advantages/Uses: This is an area that CHART may consider supporting in the future as a way to enhance traffic management (the more cars that are successfully parked at major events, the smoother traffic will flow); leverage their expertise and current installation of devices (e.g., detectors, portable DMS), and enhance current private-government partnerships for future benefits. It also contributes toward the CHART's environmental stewardship key performance area by reducing pollution caused by vehicles in congested areas waiting to get into or out of parking lots.

Disadvantages/Challenges: Identifying and qualifying specific business relationships to provide integrated parking management technology and services may be difficult.

Additionally, as with several other technologies, there are issues with third-party data sharing and the affect it can have on revenue (example: private parking lots may not want HAR broadcasts to tell drivers their lots are 90% full).

9.4 Technology Recommendations

To continue to improve CHART's performance and fulfillment of its goals and objectives, several specific suggestions for new and expanded technology capabilities were documented during the workshops. These have been summarized as mid-level requirements (not so high level as to be too generic, but not so specific as to constitute system requirements) and are listed below. Each of these was evaluated as part of the Release Strategy activities that are more fully described in Section 10. Note: No priority is intended by the order of the lists below

- Ability to handle public/private data sharing requirements
- Incorporate NTCIP-compliant cameras, detectors, HARs, and DMSs.
- Integrate AVL.
- Provide support to hand-held devices for field support and management info
- Integrate Cell Phone/GPS Tracking
- Integrate VII technologies
- Integrate Toll Tag Tracking
- Integrate with parking management systems
- Incorporate additional device status and control capabilities into CHART
- Integrate wireless mobile cameras

Note that the following technology-related mid-level requirements were captured as part of the Application Recommendations:

- Integrate with MCTMC CCTV system
- Integrate with other MDOT CCTV systems
- Integrate with other local and regional CCTV systems

10 Release Strategy and Release Plan

The release strategy and release plan presented here describes an approach to systems development that builds and deploys the CHART system in a series of releases and builds. As opposed to the "big-bang" approach, the multiple release strategy is done to divide the system into manageable sized pieces that:

- Provide enhanced functionality for CHART in a sequence consistent with operational needs.
- Lessen the impact on the operations personnel regarding training on the enhanced functionality.
- Provide reasonably sized sets of code for development, testing, and documentation.
- Allow for iterative process and system improvements over successive releases.

Since CHART is a mature, multi-jurisdictional system already, each new build will include varying degrees of the following four areas:

- New functionality for the operators
- Architecture/sustaining engineering updates
- Regional data sharing
- Problem Report fixes

This release strategy and plan includes more than just the application and data-related requirements. It includes all of the suggestions for process, technology, organizational, and location changes as well. It is important that all of these areas be considered together since there are often dependencies. (Example: There's no point in developing a user interface to control a new device type until the device has an operational requirement.)

Due to the large number of requirements, there are two components to the release strategy plan:

- **CHART System Release Plan**: Addresses the requirements for processes, data, application, and technology (PDAT); and will be executed primarily through the SHA-06-CHART contract. .

- **CHART Organization Recommendations Plan**: Addresses the requirements for organization and Location (OL); and will be executed primarily by the CHART organization itself. *Note: The contents and time frame of the requirements in the Organization Recommendations Plan are suggestions based on the workshops, and are for CHART to consider and evaluate.*

The same approach and methodology was used to develop both release plans. This approach is outlined below.

10.1 Release Plan Approach

There are five successive activities to produce a release plan from the workshop products are listed below and shown in the figure.

- Consolidate workshop input
- Determine relative business value and ease of implementation
- Identify categories of requirements and recommended releases
- Allocate each requirement to a release
- Assign each requirement to a build.

Each of these is described in more detail in the subsections that follow.

Figure 10.1-1 Release Plan Activities

10.1.1 Consolidate Workshop Input

The workshop activities generated many requirements. These were captured directly into the business process descriptions and other workshop notes, and were reviewed to extract the mid-level requirements to be evaluated for releases.

Business Area (POLDAT)[1]	*# of Mid-Level Requirements*
Process	*53*
Organization	*13*
Location	*7*
Application and Data	*28*
Technology	*9*
Total	***110***

[1]*Note that many of the Process changes will be manifested in the Application; and the Application area includes the Data requirements.*

Figure 10.1.1-1 - Number of Mid-level Requirements by Business Area

[In addition to the mid-level requirements, several other specific suggestions – below mid-level – were also captured and are listed separately in Appendix B, as candidate enhancements. They are classified by the three primary categories of change defined in the Application Section 8.3: usability, automation, integration, and intelligence.]

10.1.2 Determine Relative Business Value and Ease of Implementation

Once all the workshop input had been consolidated into mid-level requirements, the CHART Management Team and the CSC Project Team collaborated to assess each requirement to determine the relative business value and ease of implementation using several factors:

- Business value was assessed (on a scale of **L**ow, **M**edium, **H**igh) based on importance to the Operator, Political/Stakeholder, and [CHART] Administrator/Management.

- Ease of implementation (also called technical difficulty) was assessed (on a scale of **L**ow, **M**edium, **H**igh) based on how difficult it would be from the stakeholder alignment perspective, the technical perspective, on the number of dependencies (e.g., with other modules of the software, technology purchases).

A listing of all the mid-level requirements and their associated assessment of business value and technical difficulty is shown in Appendix B.

Once all the mid-level requirements had been assessed, each requirement was then plotted on a grid similar to that shown in the figure below.

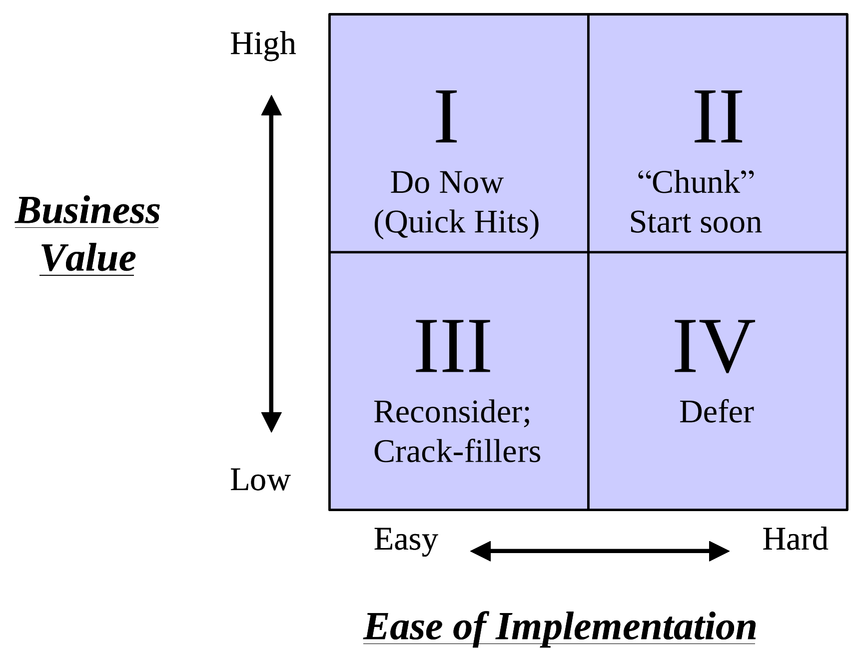


Figure 10.1.2-1 – Value-Ease Matrix for Developing Release Strategy

As noted in the introduction, two types of plans were developed: one addressing the Process, Application, Data, and Technology (PDAT), and one addressing Organization and Location (OL).

10.1.3 Identify Categories of Requirements and Initial Recommended Releases

Since there were so many mid-level requirements, it was necessary to categorize them. Once they were categorized, the contents of each category were checked against the value-ease-matrix to see how many quadrants the requirements spanned, and how many of them were in quadrant II (chunk) which would suggest that that category of requirements would need to be addressed in multiple releases. The categories, specific requirement numbers, and suggested release(s) are shown in the table below.

Figure 10.1.3-1 Categories of Requirements and Initial Recommended Releases

Category	# of reqmts	Related Rqmt #	*Initial* Recommended Release (s)*
Map	5	2, 21, 98, 106, 107	***3***
EORS/SCAN	4	22, 90, 111, 112	***4-5***
Areas of Responsibility	1	1	***3***
Decision Support	11	7, 8, 9, 10, 11, 12, 24, 25, 26, 28, 35	***4-5***
Alerts	4	15, 17, 18, 19	***3***
Signal Control	4	29, 31, 34, 89	***5***
Scheduler	2	16, 110	***3-5***
Travel Times	6	8, 13, 30, 36, 37, 38,	***3-5***
511	2	39, 102	***4***
CCTV	9	40, 41, 42, 43, 44, 45, 86, 87, 88	***3-5***
Center to Center (e.g., RITIS)	9	91, 92, 94, 95, 96, 97, 100, 101, 125	***3-4***
Simulation	4	50, 51, 52, 53	***5***
Tracking (AVL, toll tag, VII, cell phone, etc.)	5	118, 119, 120, 121, 122	***4-5***
GUI Changes (workflow, lane configuration)	7	4, 5, 14, 103, 105, 108, 109	***3***
Equipment	1	27	***4***
System and Device Health	3	6, 48, 49,	***4***
Parking Management	1	123	***5***
Event Management (EM)	3	20, 23, 32	***3***
Device Control (DC)	3	104, 116, 117	***4***
Reports	3	33, 46, 47	***4***
Leftovers	*4*	*3, 93, 99, 124*	***3-5***

*Note: Releases may have changed in subsequent analysis

10.1.4 Allocate Each Requirement to a Release

Once all the categories of requirements and associated releases had been determined, the next step was to allocate each requirement to a specific release based on a combination of factors:

- Position on the value-ease matrix
- Blend of requirements from different points on the matrix
- Interdependence of requirements
- The volume of work represented by each requirement

The release planning activity follows the general guidelines below:

- The first [post-BAA] release (CHART Release R3B1) includes many of the items from quadrant I (top left; to deliver as much business value as soon as possible), some from quadrant II (top right; to get started on the more difficult but very important requirements), only as many from quadrant III (bottom left) that must be done to satisfy a specific business urgency, none from quadrant IV (bottom right).
- The second release/build includes any remaining (or new emerging) items from quadrant I, more from quadrant II (to continue to progress on the more difficult but very important requirements), only as many from quadrant III that must be done to satisfy a specific business urgency, none from quadrant IV.
- The third and subsequent releases and builds are similar to the second release except that they will have fewer quadrant I requirements (since they will mostly have been completed), more of the quadrant III requirements, and some requirements from quadrant IV may need to be done.

The initial list of each release with its associated requirements was reviewed with CHART staff at the Release Strategy workshop where the participants reviewed the value-ease assessments, initial plotting of the requirements, and the initial release designations.

10.1.5 Assign Each Requirement to a Build

Each requirement was then compared to and reconciled with a ranked list of CHART's priorities. Then the team assigned each requirement to a build. This list of items by release and build was validated with CHART management to ensure that the releases fully meet the priorities of the mission goals of CHART.

10.1.6 New Release Approach

Starting with Release 4, the release approach has been revised. Instead of 9-12 month builds of an even larger release, CHART updates will be planned as smaller releases run in parallel. With smaller overall scope within a CHART release, more frequent updates to the system will be delivered and the development team can be more responsive to change.

10.2 Generate Release Plan

Once all the requirements have been allocated to releases and builds, the release contents were defined and could be summarized. The summarized CHART System Release Plan is shown on the figure below.

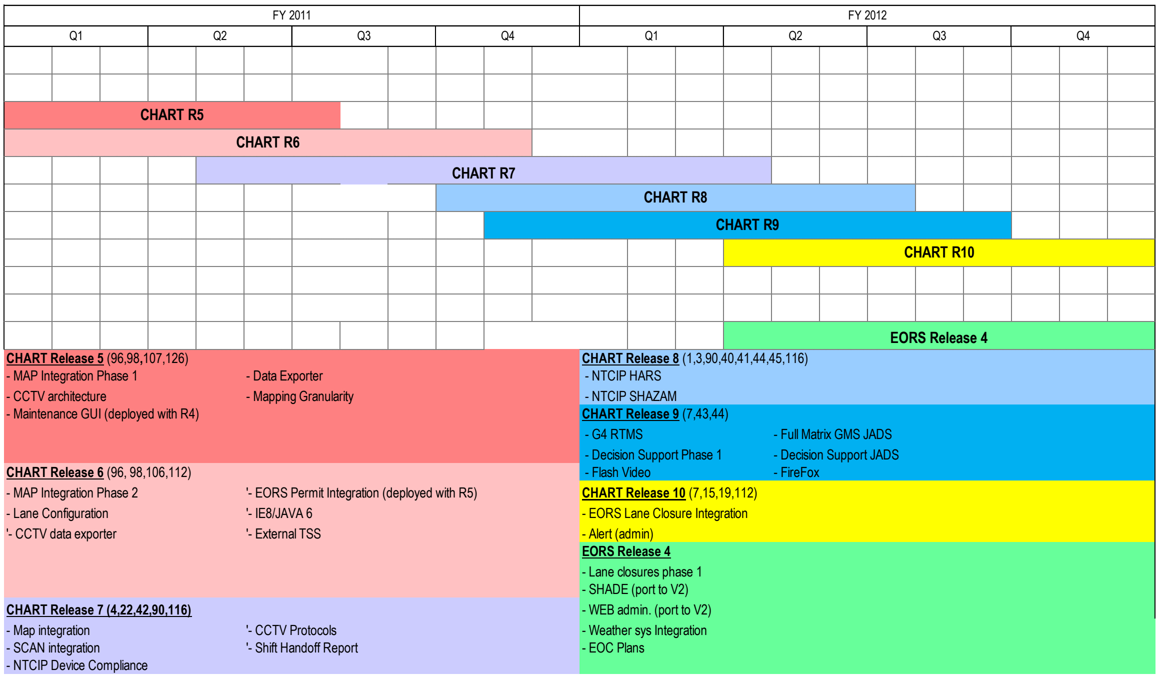


Figure 10.2-1 – CHART System Release Plan – Multi-Year Deployment Schedule

The CHART Organization Recommendations Plan, shown in the table below, represents changes that should happen at the organization and location level in parallel with the System Release Plan. *Note that this is not a system or software release plan, and represents only suggested implementation of the requirement relative to the concurrent CHART System Release Plan Builds*.

Figure 10.2-2 – CHART Organization Recommendations Plan

Rqmt #	Requirement	Suggested Concurrent with System Release
57.	Identify dedicated CHART “ambassadors” to interface with key stakeholders on a regular basis	3

Rqmt #	Requirement	Suggested Concurrent with System Release
61.	Improve retention – implement explicit mentoring program for new HOTs	3
62.	Improve retention – implement suggested minimum observation time in SOC as part of hiring process	3
63	Improve retention – implement round table interviews (vs. one-on-one)	3
64.	Improve retention – evaluate feasibility of pilot program for different types of shifts	3
66.	Training – validate requirements for new/revised training programs and develop training development plan	3
67.	Training – develop and deliver Basic CHART training program (functional and application-based).	3
68.	Training – develop and deliver application-based training for Advanced Event Management and Special Event Management	3
70.	Staffing expansion – 3 operators per shift; especially when TOCs are closed	3
71.	Staffing expansion – TOC 7	3
81.	Devices – increase coverage to less-populated areas	4
65.	Improve retention – identify and evaluate feasibility of non-monetary benefits (e.g., daycare)	4
69.	Training – develop and deliver application-based training for Reporting and System Administration	4
80.	Devices - increase number of locations by leveraging more privately or regionally owned device output (e.g., cameras, detectors, sensors)	4
82.	Devices – increase coverage by re-using existing infrastructure for new devices (e.g., radio towers, old Whellan detector locations)	4
75.	Facility, expansion – TOC 7	4
76.	Facility, new – TOC 1, Eastern Shore	4
77.	Staffing expansion – TOC 6, Allegany County	4
78.	Facility, improved work space design at police barracks and district offices	4
79.	Field operations depot	4
58.	Develop clear protocols for managing shared events and communicate them to operators and field responders for SOC, TOCs, and AOC.	4
59.	Develop improved working relationship and clear protocols with signal shop for adjusting signal timing and monitoring the effectiveness of signal adjustments during an event.	4
60.	Visibility into maintenance shop assets (equipment/vehicles)	5